Review of the Division of Computing & Communication Foundations of the National Science Foundation

For the Reporting Period FY 2003 - 2005

In compliance with the three-year review requirement, the National Science Foundation Division of Computing and Communication Foundations (CCF) convened a Committee of Visitors (COV) for two days—June 15 and 16, 2006—at NSF headquarters in Arlington, VA. The COV was composed of selected senior researchers in relevant specialty fields and was chosen to span the scientific purview of the CCF Division. During the two-day meeting, the COV reviewed a considerable amount of information about the CCF Division, including past COV reports and CCF responses, and heard presentations from CCF personnel. The COV also reviewed information about each of the three CCF Division Clusters and heard presentations from Program Directors and staff in each of these Clusters.

This report provides details of the review of the CCF Division that resulted from the COV meeting. Section 1 gives the Committee Report, which provides an overview of the Committee findings. Section 2 contains the three Cluster Reports, each of which provides details of the findings for that Cluster. Section 3 contains three Appendices, which provide additional information about the COV and the COV meeting.

Section 1
Committee Report

The Committee of Visitors (COV) review was guided by a series of questions presented by the Division of Computing and Communication Foundations (CCF) (see Appendix 3) that focused the COV's considerations. The COV review found that the CCF is dedicated to meeting its goals and to serving its intended research community. The COV also found that, overall, the CCF Division is working extremely well, and that aspects in which improvements could be made or processes reconsidered are minor.

The section consists of two parts: Executive Summary and COV Process. The Executive Summary gives an overview of CCF and presents some trends in CCF during the review period. The Executive Summary then provides overall observations and recommendations that the COV believes need attention and that apply to all three Clusters; other observations and recommendations, specific for individual Clusters, are discussed in the Cluster Reports (Section 2). The COV Process provides information about the COV membership and gives a detailed view of the process followed during the COV review. The COV Process then presents some recommendations to improve future COV reviews.

A. Executive Summary

1. Overview of Computing & Communication Foundations (CCF)

The CCF Division supports research and education activities that explore the foundations of computing and communication devices and their usage. The Division seeks advances in computing and communication theory, algorithms for computer and computational sciences, and architecture and design of computers and software. CCF-supported projects also investigate revolutionary computing paradigms based on emerging scientific ideas and integrate research and education activities to prepare future generations of computer science and engineering workers.

The CCF Division is organized into three Clusters, each of which is responsible for a related set of activities:

- Foundations of Computing Processes and Artifacts (CPA)
- Emerging Models and Technologies for Computation (EMT)
- Theoretical Foundations (TF)

In addition to the three clusters, the CCF Division supports a number of cross-directorate programs, including

- Information Technology Research (ITR)
- Science and Technology Centers (STC)

The CCF Division also supports emphasis areas that cut across CISE and across all of NSF, including

CISE 2003-06 Emphasis Areas
- Trusted Computing and Cyber Trust
- Science of Design
- Broadening Participation in Computing

NSF 2003-06 Emphasis Areas

- o Nanotechnology: NMIN, NER, NIRT
- o High-end Computing: ST-HEC and HECURA
- o Bio-complexity in the Environment
- o Mathematical Sciences: Innovations

2. Trends and Statistics

The CCF Division budget for research grants during the evaluation period grew from $134.56M in 2003 to $146.74 in 2005. This growth represents a budget increase of approximately 9% during the evaluation period. Table 1 gives the distribution of the budget across CCF Clusters, CCF administration, and cross-directorate programs.

Table 1: CCF Budgets for 2003-2005 in $M

	CPA	EMT	TF	Admin	Cross	STC	ITR	Total
2003	31	7	24	8	9	4	52	135
2004	30	6	23	5	16	4	59	143
2005	21	13	34	7	14	4	54	147

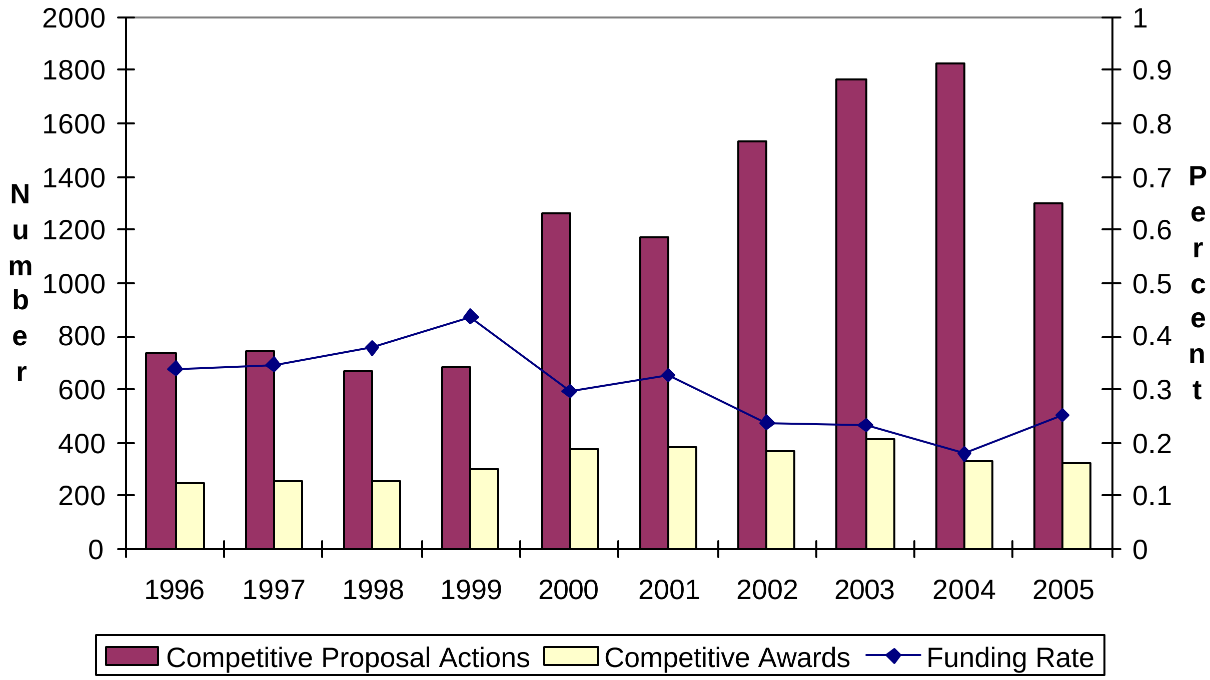
The distribution of funds across all divisions in CISE has provided the CCF Division with 22% to 24% of the CISE budget during the evaluation period. Table 2 gives the distribution of funds within CISE across all divisions.

Table 2: Distribution of CISE Funds

Division	2003	2004	2005
A/D	$1,560,797	$1,245,413	$182,379
CCF	$134,590,916	$142,838,465	$146,739,765
IIS	$119,131,969	$162,420,958	$151,317,789
SCI	$125,237,664	$121,790,047	$125,976,780
MIP			
CNS	$100,450,896	$183,483,938	$192,889,826
EIA	$105,275,763	$0	
Total	$586,248,005	$611,778,822	$617,106,539

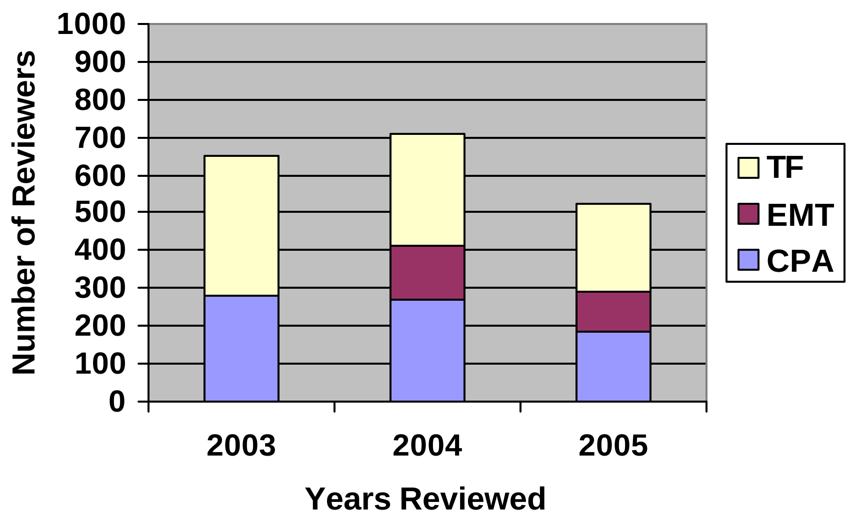
The CCF Division acted on 1850 new proposals in FY2003 and awarded 418 proposals. In FY2004 and FY2005, the Division acted on 1910 and 1356 proposals, respectively, and awarded 326 and 323 proposals, respectively. These figures include proposals that were withdrawn. Table 2 gives the distribution of the proposals for the various categories for the review period, excluding withdrawals; for comparison, the table also shows funding rates for the previous seven (7) years. Given these numbers, the success rates of proposals are 23% in FY2003, 18% in FY2004, and 25% in FY2005.

Figure 1: Funding Rate for Competitive Awards in CCF



The CCF Division enlisted the help of many reviewers, who served mostly on panels, during the review period. Figure 2 shows the distribution of reviewers among the three Clusters.

Figure 2: Distribution of reviewers across CCF Clusters

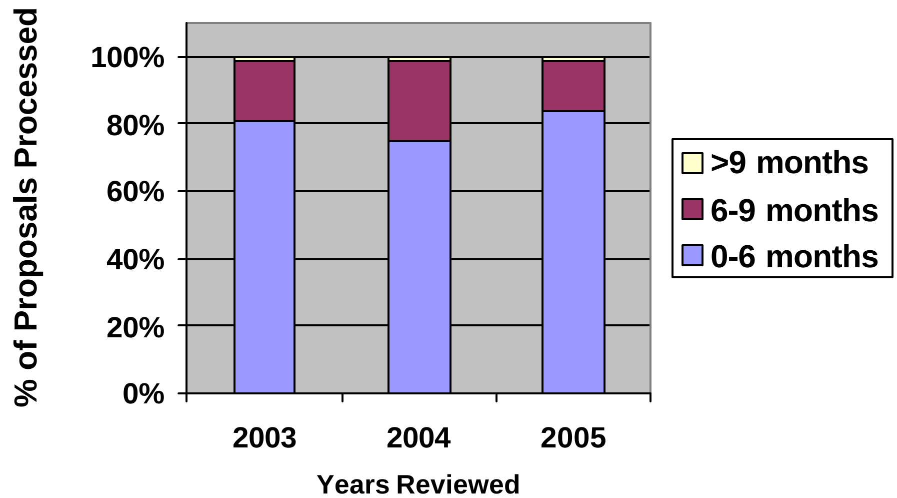


3. Observations and Recommendations

Integrity and efficiency of the program's processes and management

Overall, the COV believes that the review-panel process is excellent and the decision time has consistently met the NSF goal of processing 70% of the proposals within six months of submission Figure 3 provides data about the time to decision (i.e., *dwell time*) within the CCF Division.

Figure 3: Dwell time for CCF proposals



The COV observed, however, that some reviews are uninformative in terms of providing useful feedback to proposers. The COV believes that this lack of informative reviews may be addressable by organizing highly-focused panels, by providing targeted ad hoc (or mail) reviews for specialized areas, and by providing the Program Directors feedback to proposers.

Implementation of merit review criteria. Whereas the intellectual-merit criterion has generally been implemented appropriately, the broader-impacts criterion appears not to be well understood by either proposers or reviewers. The review comments provided by individual reviewers and by the panel summaries are often superficial and not relevant. In contrast, Program Directors do a better job of addressing this criterion in their assessments, but these comments are not always available to proposers. The COV believes that greater clarity in describing the broader-impacts criterion to proposers and reviewers would be helpful in improving the overall implementation of the merit review criteria. Although the NSF Website does provide an extensive description, the community still appears to be missing the point of the broader-impacts criterion.

Selection of reviewers. The number of reviewers per proposal is adequate. The appropriateness of the reviewers is largely good, but it is somewhat uneven in some areas, such as Theory of Computing in the Theoretical Foundations cluster, where more focus is desirable (see TF Cluster Report, A.1). The COV believes it would be helpful to let reviewers rate their level of confidence/expertise for each proposal they review as is commonly done in other peer-review venues. This rating could help guide assignment of proposals to reviewers and signal the need for additional reviews of particular proposals.

Resulting portfolio. The COV believes the overall quality of the funded proposals was excellent. However, the COV expressed significant concern about the large number of excellent yet unfunded proposals. Additionally, the funding amounts were often too small, particularly in Theory of Computing, where the amount was inadequate to support both a PI and a graduate student.

In an environment with many high-quality proposals, the panel system may not encourage funding of high-risk proposals. The COV recommends that the NSF consider development of additional processes to identify and fund high-risk proposals.

Management of CCF. The COV was impressed with the competence, dedication, outreach, and energy of the Division Director and Program Directors The reorganization into clusters should increase the flexibility of the Program Directors to respond to changes in the distribution by area of research proposals and to fund new initiatives. The COV observed that CCF Program Directors appear to be overwhelmed with the large number of proposals submitted each year. The COV thus recommends that the NSF hire additional program directors in areas with substantial number of proposals.

Outcome goals for the NSF

*For people***.** Almost every project undertaken by CISE involves the support of graduate and sometimes undergraduate students. In particular, the COV observed since 2003, CCF significantly increased its REU undergraduate research participation. It is hoped that a considerable percentage of these students will go on to graduate school (addressing a critical national need). Tables 3 and 4 provide data on the gender distribution of undergraduates and graduate students funded by the CCF division. These tables are derived from investigator reports, so that absolute numbers are likely to be underreported.

Table 3: Undergraduate Students Funded					
FY	Data	Male	Female	Unknown	Total
2003	Percentage	44.9%	14.4%	40.7%	100.0%
2004	Percentage	56.8%	16.2%	27.0%	100.0%
2005	Percentage	52.4%	14.3%	33.3%	100.0%

Nonetheless, we have enough students reported to provide credible sample estimates of the ratios of male to female students in all three years.

Table 4: Graduate Students Funded						
FY	Data	Male	Female	Declined	Unknown	Total
2003	Percentage	69.2%	17.5%	0.3%	13.0%	100.0%
2004	Percentage	73.0%	16.0%	0.0%	11.0%	100.0%
2005	Percentage	63.2%	17.0%	0.0%	11.0%	100.0%

The COV recommends that CCF develop a method to track the number of students it supports.

The COV believes that the CCF Division is dedicated to increasing the support for women and minority PIs, and its review supports this dedication. For example, during the review period, 30.7% of CCF's awards were to women and 21.1% minority PIs, a clear indication that CCF is engaged in developing a diverse group of researchers. This sample is representative of CCF's efforts on behalf of women and minorities overall. The COV also believes that the CCF Division continues to work to increase the number of new PIs and the number of PIs representing EPSCOR states. Table 5 provides data on PIs who were awarded grants during the period who are in these categories.

Table 5: Distribution of PIs			
PI Category	2003	2004	2005
New	104	81	81
Female	48	39	48
Male	298	242	220
EPSCOR	20	18	16
Underrepresented Minority	14	9	12

The COV identified a number of projects that appear to be quite promising to provide some form of significant training for the workforce. Some examples are

- NSF Award 0432013 *Information Processing in Biology* by Fred Roberts at Rutgers University. This activity supports a series of DIMACS short courses and workshops on aspects of biology involving the processing of information. During the period 6/6/05 – 5/5/06 there were 11 such short courses and workshops attended by a large number of students, postdoctoral fellows, and more senior researchers. Another six workshops are planned through 8/06.

- NSF Award 0456720 *Institute for Quantum Information (IQI)* by John Preskill of California Institute of Technology. The Institute for Quantum Information, IQI, succeeds in attracting some of the best students and postdocs in the field. To date, they have trained 20 IQI Postdocs, had long term visits from 12 researchers, and had short term visits from 50 graduate students. IQI serves as foci for quantum information science and supports summer schools with components in quantum computation.

- NSF Award 0449117 *CAREER Evolution of Signaling Mechanisms in Membrane Receptors* by Judith Klein, University of Pittsburgh. This project will investigate the understanding of dynamic processes of folding and signal transduction in membrane proteins. Being a CAREER award, it will help support the research of a junior faculty member.

- NSF Award 0244647 *CAREER: Research and Education in Video Coding and Wireless Communications,* by Maja Bystrom**,** Boston University. A team of undergraduate students working with Maja Bystrom has developed a graphical, three-dimensional file manager that has won first place in the Illustration Category of the NSF and AAAS Science "Science and Engineering Visualization Challenge". The file manager uses colors to indicate links between files and directories, and is designed to assist users in managing complex personal file systems and in traversing their file systems in an efficient and intuitive manner. A description of the award and a screen snapshot of the file manager can be found in Science, vol. 301, No. 5639, p. 1476, Sept. 2003. *This work is notable because:* This is an excellent example of the dedication shown by a CAREER awardee to the education mission of NSF.

For ideas. Although fundamental research usually has application impact about 10 to 20 years after the work is completed, the COV identified a number of projects that appear to have a high likelihood of impact on society. Many of these are detailed in Section B.2 of the Cluster Reports. Examples include

- NSF Award 0342632 *Optimal Strategies for Moving Droplets in Digital Microfluidic Systems*, by Karl Bohringer at the University of Washington. In this project, strategies for moving droplets in a complex system of micro-channels are developed so that obstacles and collision avoidance is maintained. Possible applications include ‘Lab on a Chip’ for mobile chemical analyses.

- NSF Award 0306349 *Investigations into Droplet-Based Microfluidic Technologies for Hot Spot Cooling and Thermal Management for Integrated Circuits*, by Krishnendu Chakrabarty of Duke University. Almost surely, Moore’s Law for integrated circuit scaling will be limited by the rate at which heat can be removed from integrated circuits. This novel project provides a technology base for dynamically adapting cooling locale to the positions(s) on the IC where temperatures are highest.

- NSF Award 0084479 *CAREER Software-Level Power Analysis and Optimization* by Diana Marculescu of Carnegie Mellon University. This research has shown that application-driven resource scheduling provides 50-70% performance improvements relative to static techniques and requires about 40% less energy. This result is significant with important implications for resource utilization and energy consumption by computer circuits.

- NSF Award 9971168 *Design Methodology for Mixed Analog/Asynchronous VLSI Implementations of Communications Systems*, by Chris Myers, Christian Schlegel, and Yong-Bin Kim of the University of Utah. This research has given a dramatic new approach to the design of a Maximum a-posterior (MAP) decoder using analog techniques that provides better error control and much less energy consumption. This work is significant because MAP decoders are widely used in Turbo-Codes that have widespread applications.

- NSF Award 0000987 *Noise-tolerant DSP in the Deep Submicron Era*, by Naresh R. Shanbhag of the University of Illinois at Urbana-Champaign. Inevitably as supply voltages decrease to accommodate scaling of feature sizes, noise becomes a larger fraction of the signal. A novel idea is posited to address this problem via a noise tolerance design methodology that relaxes the requirement that circuits perform in a completely error-free manner in the presence of noise. It appears that this methodology also offers the possibility of energy savings.

- NSF Awards 0524837/0524838 *QnTM: Collaborative Research: Quantum Algorithms* by Umesh Vazirani, University of California, Berkeley and Leonard Schulman, California Institute of Technology. This project explores three of the most significant challenges in Quantum Computing: the hidden subgroup problem, algorithmic cooling, and fault-tolerant quantum computation.

- NSF Award 0306382 *Games for Formal Design and Verification of Reactive Systems* by Rajeev Alur, University of Pennsylvania. In recent years, model checking has become an important tool for analyzing and verifying complex software systems. Alur's research has shown how game theory can be used to study open software systems, and specifically that the abstraction of games can capture software requirements that represent environment assumptions.

There are a number of other metrics for outcomes of ideas, including peer-reviewed journal and conference publications, patents, and citations. Much of this information is available on traditional NSF contract annual reports. Overall, the COV thinks that idea outcomes from the CCF division are satisfactory but difficult to collect and evaluate.

For tools. Tools and infrastructure are vital components of the NSF mission. Many projects contribute to this through the development of software that is made available for general use. These deserve continued encouragement and support. It was difficult to identify such projects and the facilities they provide from the data made available to the COV. However, PIs typically integrate their research and resulting tools into their teaching activities. Sometimes this material is made available to others through open courseware. Such material constitutes a significant asset and open access to these should continue to be supported. The COV recommends developing mechanisms to monitor the effect of these activities to further improve their outreach.

- NSF Award 0448658 *CAREER Realistic Models and Simulations of Systems for Quantum Information Processing*, by Todd Brun, University of Southern California. This project is developing software tools for simulating noisy quantum systems.

- NSF 052375 QnTM: *Tools for Distributed Quantum Information Processing* by Prem Kumar, Northwestern University. This project aims to develop prototype tools for distributed quantum information processing, QIP. These tools will be useful for fiber-based quantum logic and enable the development of optical based QIP.

For organizational excellence. Based on the materials available to us, the COV believes that the CCF division within the CISE directorate is indeed an innovative and agile organization. In particular, dedicated expert staff and mature business processes are a significant asset. New IT technologies are readily adopted, enabling the division to easily track trends in their operations, and allowing the division to quickly react to emerging needs and priorities. It is also evident from the COV process itself that the diverse staff of CCF (and NSF as a whole) is well trained and capable of answering on-the-fly queries concerning many aspects of division activities. The COV was unable to assess the CCF's internal business efficiency but this is presumably audited elsewhere.

B. COV Review Process

1. COV Membership

The COV to CCF in June 2006 was comprised of 20 members, including the chair, Mary Jean Harrold of Georgia Institute of Technology, and four to seven members for each of the three CCF Clusters. Expertise on the COV was selected to match the Cluster areas. The composition of the COV according to the programs under review is

- Foundations of Computing Processes and Artifacts (CPA)
  Antón, Arvind, Blanton, Cavin, Finkelstein, Knight, Thomas
- Emerging Models and Technologies for Computation (EMT)
  Adrion, Cory, Kumar, Tompa
- Theoretical Foundations (TF)
  Amato, Fortune, Hajek, Karp, Moura, Poor, Souvaine, Wright

Names, affiliations, and contact information for the COV members is provided in Appendix 2.

2. Charge to the COV

The COV review of program management considered proposal actions that were completed during the three previous fiscal years: FY 2003, FY 2004, and FY 2005 (October 1 through September 30). The three subcommittees were charged with studying and reviewing their respective Clusters. The COV review of awardee results considered examples of the direct accomplishments of projects supported by the Clusters under review that were either currently active at the time of the COV review or were closed out during the previous three fiscal years.

The COV Core Questions and Reporting Template was applied to the program portfolio and addressed the proposal review process used by the program, program management, and the results of NSF investments. Specific questions addressed and reported on are:

a. The integrity and efficiency of processes used to solicit, review, recommend, and document proposal actions, including such factors as:
   - Selection of an adequate number of highly qualified reviewers who are free from bias and/or conflicts of interest
   - Appropriate use of NSF merit review criteria
   - Documentation related to program officer decisions regarding awards and declines, and the scope, duration, and size of projects
   - Balance of awards in terms of subject matter; emerging opportunities; high risk and innovation; size versus number of awards; new investigators; diversity of underrepresented groups; geographic distribution of principal investigators; and
   - Overall technical management of the program
b. The integrity and efficiency of processes. The relationships between award decisions, program goals, and Foundation-wide programs and goals.
c. Results, in the forms of outputs and outcomes of NSF investments for the relevant fiscal years, as they relate to the Foundation’s current strategic goals and annual performance goals.
d. The significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when these investments were made. Examples might include new products or processes, or new fields of research

whose creation can be traced to the outputs and outcomes of NSF-supported projects over an extended period of time.

e. Response of the program(s) under review to recommendations of the previous COV review.

3. Methodology

The COV meeting opened with welcoming remarks by Assistant Director of NSF for CISE Peter Freeman. Then CCF Division Director Mike Foster gave an overview of the CCF Cluster Reconstruction and on the activities of CCF over the review period. Next, COV Chair Mary Jean Harrold introduced the COV Co-chairs, gave an overview of the COV procedures, and provided an outline for the final report. Appendix 1 gives a copy of the Meeting Agenda, Appendix 2 lists the membership of the COV, and Appendix 3 gives the Report Template that was used for all Cluster Reports and to guide the Committee Report.

Before the COV meeting, the COV was provided some documentation for its two-day meeting, including succinct descriptions of the charge to the Committee and its obligations in responding. Additional information and data were provided at the COV meeting.

During the review, the COV met in both plenary and subcommittee meetings throughout the two-day meeting. During the subcommittee sessions, the groups were provided extensive proposal documentation, as well as individual conference rooms in which to conduct their studies. Each subcommittee was instructed to respond to the template items with the intent of providing detailed review of their subcommittee's cluster and of revealing those points where consensus could be achieved across the three COV subcommittees. During the plenary sessions, the COV would discuss to topics from the subcommittees' reviews for group analyses, perform comparisons of status of the respective studies, identify common issues, and plan remaining sessions.

Toward the end of the two-day review, an executive summary of the major recommendations was presented and discussed with Peter Freeman, Assistant Director of NSF for CISE, Mike Foster, CCF Director, Deborah Crawford, Deputy Assistant Director, Sanya L. Spencer, Operations Manager, and Velma Lawson, Integrative Activities Specialist.

4. Evaluation of the COV Process

The COV found the COV review process to be challenging because of several organizational issues, and recommends that the following be considered for any future reviews:

Before the review. The COV encourages CCF and all CISE divisions to have the COV chair and Co-chairs arrive a day early to review the available materials, meet with the division staff, and prepare for the meeting to ensure the COV objectives are clear and that the meeting is planned accordingly. The COV also expressed an interest in participating in a teleconference a few weeks before the COV meeting to clarify the COV goals and objectives, and to ensure that materials are made available for early analysis and discussion.

Structure of meeting. The COV encourages CCF to consider extending the COV meeting time to three days in the future (as some other NSF Directorates do) to ensure that the COV has adequate time for discussion and preparation of recommendations and the final report. Ideally, on the first day, there would be a full day of presentations by the CCF staff in which the data needed to give proper consideration to each question are provided. On the second day, the morning could be devoted to the breakout sessions by the subcommittees followed by follow-up presentations by the CCF staff in response to requests for additional information/clarification by the COV.

Availability of data. The availability of data and additional time would have enabled the COV to engage in more deep, strategic thinking rather than devoting a large portion of the time attempting to find data or requesting data from the CCF staff. Additionally, it would be helpful to have access to the annual reports and final reports for the awarded proposals for proper consideration of the "outcome" questions (found in Part B of the Report Template, which is reproduces in Appendix 3).

Section 3
Cluster Reports

Each of the COV subcommittees reviewed one cluster, and completed the Report Template for that cluster. This section provides the Cluster Reports for the three CCF clusters: Foundations of Computing Processes and Artifacts Cluster (CPA), Emerging Models and Technologies for Computation Cluster (EMT), and Theoretical Foundations Cluster (TF).

FY 2006 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (COV)
Foundations of Computing Processes and Artifacts Cluster (CPA)

Date of COV: June 15-16, 2006
Program/Cluster/Section: Foundations of Computing Processes and Artifacts (CPA)
Division: Computing & Communication Foundations
Directorate: Computer Information, Science and Engineering (CISE)
Number of actions reviewed: Awards: 15 Declinations: 35 Other:
Total number of actions within Program/Cluster/Division during period under review: **Awards: 317 Declinations: 1137 Other: 48**
Manner in which reviewed actions were selected: The COV CPA subcommittee reviewed proposal files first in accordance with a committee members area of expertise and then random selections were made from the files.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Part A discusses and provides comments for each relevant aspect of the program's review process and management. Comments are based on the CPA subcommittee's review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Comments are provided for each program reviewed and for those questions that were relevant to the program under review. Quantitative information was not available for all questions. In these cases, "Data Not Available" is indicated in the right hand column of the tables below. Constructive comments noting areas in need of improvement are provided as well.

A.1 Quality and effectiveness of the program's use of merit review procedures.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCEDURES	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]
1. Is the review mechanism appropriate? (panels, ad hoc reviews, site visits) Comments: Overall, the process seems to be good and working well. Peer review is an important feature that should receive continuing emphasis.	YES

[1] If "Not Applicable" please explain why in the "Comments" section.

2. Is the review process efficient and effective? Comments: The proposal selection process is extremely effective, however it is NSF- resource intensive. The Conflict of Interest requirement sometimes makes it difficult to find qualified reviewers.	YES
3. Do the individual reviews (either mail or panel) provide sufficient information for the principal investigator(s) to understand the basis for the reviewer's recommendation? Comments: In most cases reviewed by the COV, the reviews provide sufficient information for effective decision processes. Program managers have the freedom to challenge the results of individual reviews. The quality of the reviews is inconsistent, however. A minority of reviews provide insufficient evidence for why the proposal received its rating or suggestions for how to improve the proposal for future submission.	YES
4. Do the panel summaries provide sufficient information for the principal investigator(s) to understand the basis for the panel recommendation? Comments: There is a natural variation in quality; at best the summaries are excellent. There are inevitably exceptions to this.	YES
5. Is the documentation for recommendations complete, and does the program officer provide sufficient information and justification for her/his recommendation? Comments: The CPA subcommittee found that the Program Director's summaries were particularly well-written, useful, and provided good accounts of the rationale. It would assist PIs if some of this was available to them.	YES
6. Is the time to decision appropriate? Comments: Virtually all decisions are made within nine (9) months after receipt of proposal. A sizeable proportion of decisions are made within six (6) months. This is close to the NSF target of 70% of review completion/PI notifications within six (6) months.	YES

7. Additional comments on the quality and effectiveness of the program's use of merit review procedures:

Comments: The reviewer selection and panel composition is generally excellent.

A.2 Implementation of the NSF Merit Review Criteria (intellectual merit and broader impacts) by reviewers and program officers.

IMPLEMENTATION OF NSF MERIT REVIEW CRITERIA	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE [2]
1. Have the individual reviews (either mail or panel) addressed both merit review criteria? Comments: Primary review effort appears to be on intellectual merit. Intellectual merit and broader impacts are carefully evaluated but not consistently articulated in individual reviews. The lack of detail in the reviews for broader impacts may be a function of the difficulty to evaluate it. The CPA subcommittee suggests that the fields in FASTLANE be changed to require responses to each of the five questions respectively for each area. The subcommittee also suggests that the detailed questions be reviewed for understandability.	Yes
2. Have the panel summaries addressed both merit review criteria? Comments: Most cover both topics, but less so on broader impacts.	Yes
3. Have the *review analyses* (Form 7s) addressed both merit review criteria? Comments: In most cases, they were well done.	Yes
4. Additional comments with respect to implementation of NSF's merit review criteria: The COV recommends that on the review form an indication by the reviewer of her/his level of expertise for each proposal being reviewed.	

[2] In "Not Applicable" please explain why in the "Comments" section.

A.3 Selection of reviewers.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE [3]
1. Did the program make use of an adequate number of reviewers? Comments: Each COV member reviewed at least six jackets (over 50 jackets were reviewed by the subcommittee) from the sample that was made available. The number of reviewers on the sample reviewed by the panel ranged from three (3) to six (6).	Yes
2. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: Program Directors play an important role in ensuring that the balance between young professionals and more experienced professionals is appropriate in each case. In general, the reviewers were completely appropriate for the proposals. There are a few occasions where reviewers were less well-informed. This is, however, within the acceptable range for peer review.	Yes
3. Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups?[4] Comments:	No data available
4. Did the program recognize and resolve conflicts of interest when appropriate? Comments: This appears to be done very well and conscientiously.	Yes
5. Additional comments on reviewer selection:	

[3] If "Not Applicable" please explain why in the "Comments" section.
[4] Please note that less than 35 percent of reviewers report their demographics last fiscal year, so the data may be limited.

A.4 Portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[5], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: Based on what was presented to the COV, it was impressed by the quality of the research and education projects.	Appropriate
2. Are awards appropriate in size and duration for the scope of the projects? Comments: It appears that awards were on average at about 65% of requested. This is likely driven by the desire to award as many projects as possible within the scope of a non-increasing budget and in the face of increased numbers of proposal submissions.	Appropriate
3. Does the program portfolio have an appropriate balance of: • Innovative/high-risk projects?[6] Comments: Based on estimates provided to the COV, 100% of SGER projects are high risk, approximately 50% of Science of Design projects are high risk, and 30% of ITR projects are high risk. Overall, there appears to be an appropriate balance.	Yes
4. Does the program portfolio have an appropriate balance of: • Multidisciplinary projects? Comments: It is extremely difficult to judge the appropriateness of multidisciplinary projects based on reviewing the CPA cluster alone because much of the multi-disciplinarity lies in the cross-cutting programs. Within CPA, there is a need to encourage multi-disciplinary projects.	Yes
5. Does the program portfolio have an appropriate balance of: • Funding for centers, groups and awards to individuals? Comments: CPA has no Research Centers; one in TF and one in EMT in	Not applicable

[5] If "Not Appropriate" please explain why in the "Comments" section.
[6] For examples and concepts of high risk and innovation, please see Appendix III, p. 66 of the Report of the Advisory Committee for GPRA Performance Assessment, available at <www.nsf.gov/about/performance/acgpa/reports.jsp>.

CCF. The CPA subcommittee encourages the consideration of centers in CPA	
6. Does the program portfolio have an appropriate balance of: • Awards to new investigators? Comments: 23% of PIs in 2003, 25% of PIs in 2004, and 26% of PIs 2006 were new to CPA. We believe that this represents an appropriate revitalization of the research program.	Yes
7. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: There does not appear to be a geographical bias and awards were made in most states. However, in 2005, 22% of the awards went to three states, in 2004, 42% of awards went to 4 states, and in 2003, 55% of the awards went to 7 states.	Yes
8. Does the program portfolio have an appropriate balance of: • Institutional types? Comments: Most awards went to Ph.D.-granting universities and the COV believes that this is appropriate.	Yes
9. Does the program portfolio have an appropriate balance of: • Projects that integrate research and education? Comments: This is a positive aspect of the projects and a distinctive characteristic of NSF grants relative to other international agencies.	Yes
10. Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity and of emerging opportunities? Comments: The CPA subcommittee believes that this is well done but have insufficient data.	No data available
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: Over the period 2003 to 2005, 18.3% of the awards in CPA went to women and minorities. The CPA subcommittee encourages CPA to continue to focus on increasing the participation of women and minorities in its programs. However, CPA is funding an appropriate percentage of proposals received from women and minorities, but the number of proposal	Yes

submissions needs to be increased.	
12. Is the program relevant to national priorities, agency mission, relevant fields and other customer needs? Include citations of relevant external reports. Comments: The subcommittee believes that the science and technology research conducted by CPA cluster is essential to sustaining U.S. competitiveness in information technologies. It believes that the CPA program aligns well with the thrust of "Rising Above the Gathering Storm: Energizing and Employing American for a Brighter Future," The National Academy Press, 2006	Yes
13. Additional comments on the quality of the projects or the balance of the portfolio: Comments: As evidenced by the number of highly competitive proposals that were declined by CPA, important high-quality research is not being funded. The acceptance rate, (~10%) in this area of vital importance for national competitiveness falls below international benchmarks (15-20%).	

A.5 Management of the program under review.

1. Management of the program. Comments: The CPA Program Directors are highly qualified, committed to the NSF mission, and have good support from the NSF management structure. Given the increasing number of proposals being received each year, management appears to be understaffed. The CPA subcommittee encourages NSF to add additional Program Directors so that Program Directors are not overburdened in areas where the largest number of proposals is received.
2. Responsiveness of the program to emerging research and education opportunities. Comments: It appears that the Program Directors use different means (e.g., cluster reserves) to determine new and important research directions including the use of workshops, professional contacts, and solicitation of out-of-the box proposals. Increased funding would enable Program Directors to be more flexible in responding to new opportunities for research.
3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments: The CPA division is an integral part of the larger CISE internal planning processes. It was indicated to the COV, for example, that the division is considering refining the current cluster structure but leaving the CPA components substantially in place. The CPA subcommittee believes that this makes sense but would emphasize the importance of financial stability. In addition, CISE utilizes an external Advisory Committee to make recommendations on strategic directions for the Directorate, and hence the CISE divisions. The CPA subcommittee believes that the planning/prioritization processes are satisfactory.
4. Additional comments on program management:

PART B. RESULTS OF NSF INVESTMENTS

B. Activities Relating to NSF's Strategic Outcome Goals.

B.1 <u>OUTCOME GOAL for PEOPLE</u>: Developing "a diverse, competitive and globally engaged workforce of scientists, engineers, technologists and well-prepared citizens."

Comments: Almost every project undertaken by CISE involves the support of graduate and sometimes undergraduate students. In particular, the CPA subcommittee observed that in 2005, CISE significantly increased support for the REU program by involving over 100 undergraduates in research. This is quite significant in that all these students are U.S. citizens or permanent residents, and experience shows that a high percentage will go on to graduate school, addressing a critical national need. The number of graduate students supported in a given year is more difficult to determine but the subcommittee estimates that the average loaded cost of a graduate student is on the order of $60K/year. Thus, since the total CCF cluster budget for 2005 was about $120M, CCF probably supported about 1,000 graduate students in 2005—a vital contribution to the national priorities in science and engineering. The CPA subcommittee recommends that CCF develop a method to track the number of students it supports. Over the last three years, 18.3% of CPA's awards were to women and minority PIs, a clear indication that CPA is engaged in developing a diverse group of researchers.

B.2 <u>OUTCOME GOAL for IDEAS</u>: Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."

Comments: The CPA subcommittee would like to begin with the proviso that fundamental research usually has application impact about 10 to 20 years after the work is completed. Even so, the subcommittee identified several projects that appear to have a high likelihood of impact on society.

NSF Award 0342632 Optimal Strategies for Moving Droplets in Digital Microfluidic Systems
PI: Karl Bohringer
Institution: University of Washington
In this project, strategies for moving droplets in a complex system of micro-channels are developed so that obstacles and collision avoidance is maintained. Possible applications include 'Lab on a Chip' for mobile chemical analyses.

NSF Award 0306349 Investigations into Droplet-Based Microfluidic Technologies for Hot Spot Cooling and Thermal Management for Integrated Circuits
PI: Krishnendu Chakrabarty
Institution: Duke University
Almost surely, Moore's Law for integrated circuit scaling will be limited by the rate at which heat can be removed from integrated circuits. This novel project provides a technology base for dynamically adapting cooling locale to the positions(s) on the IC where temperatures are highest.

NSF Award 0084479 CAREER Software-Level Power Analysis and Optimization
PI: Diana Marculescu
Institution: Carnegie Mellon University
This research has shown that application-driven resource scheduling provides 50-70% performance improvements relative to static techniques and requires about 40% less energy. This is a significant

result with important implications for resource utilization and energy consumption by computer circuits.

NSF Award NSF Award 9971168 Design Methodology for Mixed Analog/Asynchronous VLSI Implementations of Communications Systems
PIs: Chris Myers
Institution: University of Utah
This research has given a dramatic new approach to the design of a Maximum a-posterior (MAP) decoder using analog techniques that provides better error control and much less energy consumption. This is significant since MAP decoders are widely used in Turbo-Codes that have widespread applications.

NSF Award 0000987 Noise-tolerant DSP in the Deep Submicron Era
PI: Naresh R. Shanbhag
Institution: University of Illinois at Urbana-Champaign
Inevitably as supply voltages decrease to accommodate scaling of feature sizes, noise becomes a larger fraction of the signal. A novel idea is posited to address this problem via a noise tolerance design methodology that relaxes the requirement that circuits perform in a completely error-free manner in the presence of noise. It appears that this methodology also offers the possibility of energy savings.

NSF Award 9971195 A Verification manager for Adaptive Model Checking
PI: Fabio Somenzi and Gary D. Hachtel
Institution: University of Colorado at Boulder
These distinguished investigators whose earlier work contributed to the model checker, VIS, have extended its applicability by developing the underlying theoretical basis to include adaptation. This work lies broadly in the area of formal verification of integrated circuits and is of significant importance because it could greatly improve the quality verification technology and possibly reduce verification times that now consume up to 50% of design time.

B.3 OUTCOME GOAL for TOOLS: Providing "broadly accessible, state-of-the-art S&E facilities, tools and other infrastructure that enable discovery, learning and innovation."

Comments: CPA co-funds several of the Nano-Centers that are chartered to provide research infrastructure. In the software area, tools result from the Design Automation research that has wide application in academia and industry. In addition, almost all proposals contain a plan to develop new educational modules for students. The CPA subcommittee recommends that CISE support the

Open Courseware activity.

B.4 <u>OUTCOME GOAL for ORGANIZATIONAL EXCELLENCE</u>: Providing "an agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices."[7]

Comments: The CPA subcommittee believes that the commitment to openness of CPA to new ideas from the Computer Science and Engineering community is an essential ingredient to agility and innovation. Within the bounds of the panel review process employed by NSF, the subcommittee believes that CPA responds remarkably well to new ideas and to national initiatives. Flexibility is limited by the need of NSF to accommodate student life cycles by funding longer-term projects, but the subcommittee thinks that a reasonable balance between student support and agility is sustained.

PART C. OTHER TOPICS

C.1 Program areas in need of improvement or gaps within program areas.

There are a number of key drivers that the CPA subcommittee expects to shape the cluster and its future:

1. Physical constraints on integrated circuit scaling
2. Increasing ubiquity of computing devices; notably handheld
3. Demands for software with challenging non-functional constraints such as performance and reliability accompanied by the need for rapid deployment,
4. Growth in data volume with accompanying need for analysis,
5. Increasing demand for management of complex software infrastructures.

C.2 Program's performance in meeting program-specific goals and objectives that were not covered by the above questions.

Overall, the CPA subcommittee thinks that the program is responding well to its specific goals and objectives as indicated in the responses above.

C.3 Agency-wide issues that should be addressed by NSF to help improve the program's performance.

The peer/panel review process, central to the successful operation of NSF programs is essential but places a severe burden on NSF staff and requires significant resources. Innovative approaches to achieving the objectives of funding very high quality research programs, retaining the panel review process, but reducing resource commitments, need to be studied.

The CPA subcommittee is concerned about replacing the highly successful FASTLANE with GRANTS.Gov, which is not tailored to the support the missions of basic research, a distinguishing characteristic of NSF.

[7] For examples and further detail on the Organizational Excellence Goal, please refer to pp. 19-21 of NSF's Strategic Plan, FY 2003-2008, at <http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf04201>.

C.4 Other issues the COV feels are relevant.

There should be greater transparency to the COV of budget allocation processes within CISE.

C.5 How to improve the COV review process, format and report template.

The CPA subcommittee suggests that in preparation for the next COV review, the NSF staff consider providing statistically-significant data that will aid deliberation of each question in the COV report and also provide the COV with back-up information intended to support their positions. One of the difficulties with the present arrangement is that the COV must either try to extract the information by identifying and reviewing numerous documents provided to it or it must ask NSF staff to generate the required data during the COV meeting.

SIGNATURE BLOCK:

____

For the Foundations of Computing Processes and Artifacts Cluster Subcommittee
2006 Computing and Communications Foundations Division COV
Dr. Ralph Cavin
Co-Chair for the Foundations of Computing Processes and Artifacts Cluster Subcommittee
Dr. Mary Jean Harrold
Chair 2006 Computing and Communications Foundations Division COV

FY 2006 REPORT FOR
NSF COMMITTEES OF VISITORS (COV)
Emerging Models and Technologies for Computation Cluster (EMT)

Date of COV: June 15-16, 2006
Program/Cluster/Section: Emerging Models and Technologies for Computation (EMT)
Division: Computing & Communication Foundations
Directorate: Computer Information, Science and Engineering (CISE)
Number of actions reviewed: Awards:16 Declinations:13 **Other:**
Total number of actions within Program/Cluster/Division during period under review: **Awards: 90 Declinations: 211 Other: 16**
Manner in which reviewed actions were selected: **The COV EMT subgroup selected from all FY03-05 awards and from FY05 declinations. The 12 "randomly selected" awards and declinations from FY03-05 (provided by the Division) were reviewed where possible, but conflicts limited their useful to the COV review. The e-Jacket system made it difficult to obtain immediate access to additional (not selected in advance by the Division) jackets, as each had to be entered individually by Division staff.**

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Part A discusses and provides comments for *each* relevant aspect of the program's review process and management. Comments are based on the EMT subcommittee's review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Comments are provided for *each* program reviewed and for those questions that were relevant to the program under review. Quantitative information was not available for all questions. In these cases, "Data Not Available" is indicated in the right hand column of the tables below. Constructive comments noting areas in need of improvement are provided as well.

A.1 Quality and effectiveness of the program's use of merit review procedures.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCEDURES	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE [8]
1. Is the review mechanism appropriate? (panels, ad hoc reviews, site visits) Comments: In FY03, 66 proposals were reviewed by panels with a limited number of ad hoc mail reviews; in FY04, 137 proposals were entirely panel	Yes

[8] If "Not Applicable" please explain why in the "Comments" section.

reviewed; and in FY05, 163 proposals were panel reviewed with supplemental ad hoc reviews. The COV EMT subcommittee believes panel reviews are the best primary means for review, but given the complexity and interdisciplinarity of the proposals, the COV EMT subcommittee encourages the EMT cluster to expand its use of supplemental mail reviews. In particular the EMT staff willingness to engage mail reviewers by telephone conference during the panel has made it possible for them to review a broad range of technologies, which is especially critical for this program. We encourage the program managers to engage as many mail reviewers as possible through this mechanism.	
2. Is the review process efficient and effective? Comments: The EMT subcommittee believes the review process is efficient, particularly with respect to decision timeliness. Several alternative processes were discussed, including early release (before final decision) of the panel summaries. However, the laudable time-to-decision metrics achieved by the program (see #6 below) may make these alternatives unnecessary. As to effectiveness, the EMT subcommittee compliments the EMT Program Directors on the quality of decisions given the complexity and interdisciplinary nature of the proposals.	Yes
3. Do the individual reviews (either mail or panel) provide sufficient information for the principal investigator(s) to understand the basis for the reviewer's recommendation? Comments: Overall, EMT has engaged excellent reviewers and through a combination of ad hoc and panel reviews has managed to obtain detailed and useful reviews. In some cases, these are accompanied by less informed and less specific reviews. In particular the EMT subcommittee found some reviews to be superficial and lacking sufficient detail to provide feedback to the PIs. There were several reviews that simply restated the goals of the proposal in the review without providing constructive feedback to the proposal writer. This feedback is critical for proposal writers, especially for PIs who may not be experienced at writing proposals.	Yes
4. Do the panel summaries provide sufficient information for the principal investigator(s) to understand the basis for the panel recommendation? Comments: The panel summaries are adequate. However, the quality of the summaries could be improved. It is incumbent upon the panel members to provide constructive feedback about how to improve the quality of the proposal and make the resubmission viable.	Yes
5. Is the documentation for recommendations complete, and does the program officer provide sufficient information and justification for her/his recommendation? Comments: The EMT subcommittee compliments the EMT cluster team on the	Yes

quality of the documentation.	
6. Is the time to decision appropriate? Comments: The time-to-decision averages for the EMT Cluster (4.5 months in FY04 and 4.9 months in FY05) and the percentage of proposals reviewed within 6 months (99% in FY04 and 95% months in FY05) are typically, if not far, better than most other programs in the Division, Directorate and Foundation.	Yes
7. Additional comments on the quality and effectiveness of the program's use of merit review procedures: Comments: EMT has managed to engage some relatively young panel members, which the COV views positively. However, it would be beneficial to provide additional instructions to young panelists concerning review expectations, especially relating to "Broader Impacts." The COV EMT subcommittee suggests that more time be spent discussing the two sets of criteria at the start of the panel. It is essential that the program officer maintain flexibility in the use of panel reviews.	

A.2 Implementation of the NSF Merit Review Criteria (intellectual merit and broader impacts) by reviewers and program officers.

IMPLEMENTATION OF NSF MERIT REVIEW CRITERIA	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE [9]
1. Have the individual reviews (either mail or panel) addressed both merit review criteria? Comments: Overall, the COV EMT subcommittee found that reviewers attempted to address both criteria as required, but often the comments on the broader-impacts criterion were superficial and/or missed the point of the criterion. The EMT subcommittee suggests that more time be spent discussing these criteria at the start of each panel.	Yes
2. Have the panel summaries addressed both merit review criteria? Comments: Panel summaries, in most cases, are better in addressing the IM and BI criteria than the individual reviews. The EMT subcommittee found a few examples in FY03 and FY04 where these criteria were not adequately addressed; the subcommittee found no cases in FY05 where the review criteria were not addressed.	Yes
3. Have the *review analyses* (Form 7s) addressed both merit review criteria? Comments: Even when the Panel Summaries did not adequately address both criteria, the Program Directors usually did.	Yes
4. Additional comments with respect to implementation of NSF's merit review criteria: None	

[9] In "Not Applicable" please explain why in the "Comments" section.

A.3 Selection of reviewers.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE [10]
1. Did the program make use of an adequate number of reviewers? Comments: In each of the three years an adequate number of reviews/proposal were obtained (FY03 270 reviews for 66 proposals; FY04 543 reviews for 137 proposals; FY05 585 reviews for 163 proposal), averaging over four (4) reviews per proposal. The EMT subcommittee determined that there was minimal overlap in the 50-60 reviewers used each year.	Yes
2. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: The program did a very good job in selecting reviewers, particularly through the use of supplemental ad hoc mail reviews.	Yes
3. Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups?[11] Comments: The panels had a good mix of junior and senior researchers, having the benefit of helping the newer faculty. In the time available for the COV review, the EMT subcommittee was not able to review data on geographical, institutional and ethnic/gender distribution. These data should be made available in advance of the meeting. The subcommittee's impression is that there was balance in the selection of reviewers.	No data available
4. Did the program recognize and resolve conflicts of interest when appropriate? Comments: The EMT subcommittee interviewed the primary Program Director on her strategy for handling COIs. The process (PM overview, reviewer self-identification of COI, requirement for reviewers to absent and recuse themselves from discussions involving proposals with which they have a COI) was adequate. No problems were identified that resulted from this process.	Yes

[10] If "Not Applicable" please explain why in the "Comments" section.
[11] Please note that less than 35 percent of reviewers report their demographics last fiscal year, so the data may be limited.

5. Additional comments on reviewer selection: It would be useful to have a subset of the panel reviewers serve on consecutive panels to ensure that resubmissions are evaluated consistently. One possible approach might be to recruit ad hoc reviewers (possibly to provide mail reviews or participate in the panel meeting by phone) from the panel that reviewed the original submission. The COV also recognized the need to engage new reviewers, and there is clearly a trade-off.	

A.4 Portfolio of awards under review.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[12], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: The overall quality of the awards was very high. There were few education projects, but education projects are primarily supported in other CISE programs. See examples in Section B.	Yes
2. Are awards appropriate in size and duration for the scope of the projects? Comments: The COV EMT subcommittee primarily evaluated the FY04-05 actions in the EMT Cluster and not the FY03 QuBIC and BITS/BIC programs. The median annual award size grew from $90K to $100K while the mean award duration remained at close to three years. While this is a modest level of support, the Program Director did indicate an intention to create a "large" award category for FY06 and beyond. The EMT subcommittee strongly encourages making some larger awards. Within CCF, only a few specialized and targeted programs (e.g., Cybertrust, Science of Design) had significantly larger annual median award sizes. The EMT subcommittee is concerned, particularly in a program investigating "emerging technologies," that successful projects cannot be taken to the next experimental step with the current level of available funding.	Yes
3. Does the program portfolio have an appropriate balance of: • Innovative/high-risk projects?[13] Comments: This is the program focus. See Section B for examples.	Yes
4. Does the program portfolio have an appropriate balance of: • Multidisciplinary projects? Comments: Because of the nature and mission of the EMT cluster, all of the awards are multidisciplinary. See Section B.	Yes

[12] If "Not Appropriate" please explain why in the "Comments" section.
[13] For examples and concepts of high risk and innovation, please see Appendix III, p. 66 of the Report of the Advisory Committee for GPRA Performance Assessment, available at <www.nsf.gov/about/performance/acgpa/reports.jsp>.

5. Does the program portfolio have an appropriate balance of: • Funding for centers, groups and awards to individuals? Comments: Within the EMT Cluster, the Program Directors typically make only a few group awards and no center awards. Because the Cluster focuses on “emerging technologies” this seems appropriate, but there should be a mechanism for expanding research where very promising outcomes occur. Currently this is accomplished, in a limited way, by co-funding with other programs.	Yes
6. Does the program portfolio have an appropriate balance of: • Awards to new investigators? Comments: The funding rate for new PIs was similar to the overall funding rate and 40% of the awards went to new PIs. In addition, four CAREER awards were made.	Yes
7. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: In the limited time, the EMT subcommittee was unable to review data on geographical, institutional and ethnic/gender distribution. These data should be made available in advance of the meeting.	No data available
8. Does the program portfolio have an appropriate balance of: Institutional types? Comments: In the limited time, the COV EMT subcommittee was unable to review data on geographical, institutional and ethnic/gender distribution. These data should be made available in advance of the meeting.	No data available
9. Does the program portfolio have an appropriate balance of: • Projects that integrate research and education? Comments: There are examples of projects that have a significant educational component, but as one would expect in a program focused on emerging technologies, most projects are primarily focused on research.	Yes
10. Does the program portfolio have an appropriate balance: • Across disciplines and sub-disciplines of the activity and of emerging opportunities?	Yes

Comments: Yes, by the nature and mission of the EMT Cluster.	
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: 18% of the awards went to women PIs and 6% to underrepresented minority PIs. The EMT subcommittee encourages the Program Directors to continue to work to improve on these numbers. This is clearly a high priority for the Program Director, CISE and the NSF.	Yes
12. Is the program relevant to national priorities, agency mission, relevant fields and other customer needs? Include citations of relevant external reports. Comments: Yes. Some examples of studies, reports and workshops that clearly have influenced the Cluster planning and operations include o Catalyzing Inquiry at the Interface of Computing and Biology, John C. Wooley and Herbert S. Lin, Editors, Committee on Frontiers at the Interface of Computing and Biology, National Research Council o Capitalizing on New Needs and New Opportunities: Government-Industry Partnerships in Biotechnology and Information Technologies Charles W. Wessner, Editor, Board on Science, Technology, and Economic Policy, National Research Council o Computer Science: Reflections on the Field, Reflections from the Field, Committee on the Fundamentals of Computer Science: Challenges and Opportunities, National Research Council o A Quantum Information Science and Technology Roadmap Report of the Quantum Information Science and Technology Experts Panel ARDA o "Synergistic Approaches for Understanding Information Processing in Biological and Artificial Intelligent Systems," held on April 8-10, 1996. o "Biological Computation: How does biology do information technology," held on September 21, 2000.	Yes
13. Additional comments on the quality of the projects or the balance of the portfolio:	

A.5 Management of the program under review.

1. Management of the program. Comments: The EMT subcommittee primarily examined the management of the cluster in FY04-05, since in FY03 the programs transferred in from another division. Overall, the Program Directors (and particularly the lead Program Director is to be congratulated for the management of the program – time-to-decision was better than most other decisions, the panels and panelists were well chosen, the portfolio of awards is very good. The lead Program Director traveled, to promote the program and to recruit proposals; the result was a large number of new PIs. She did an excellent job of coordinating the program within NSF and across agencies.
2. Responsiveness of the program to emerging research and education opportunities. Comments: The cluster is targeted towards emerging models and technologies. Thus, by its mission, it is directed at encouraging research in new areas; something the staff does very well. There were fewer education-focused activities in the cluster; perhaps this will improve as the cross-directorate education programs get underway. When opportunities to support educational activities arose, the lead program manager was active in finding support for them.
3. Program planning and prioritization process (internal and external) that guided the development of the portfolio. Comments: The lead program manager, as noted, interacted within the division, across NSF and across agencies; she visited a number (25) of institutions and attended several workshops and symposia. Among these were: Panels on Computational Biology and Bioinspired Computing in international conferences (RECOMB, ISMB), IEEE Nano conference, FNANO conference; Interagency workshop on Research at the interface of the life sciences and physical sciences (NSF-NIH). She also attended other agency PI meetings and reviews.
4. Additional comments on program management: None.

PART B. RESULTS OF NSF INVESTMENTS

B. Comments on the activity as it relates to NSF's Strategic Outcome Goals.

B.1 OUTCOME GOAL for PEOPLE: Developing "a diverse, competitive and globally engaged workforce of scientists, engineers, technologists and well-prepared citizens."

Comments: Over the period Fy03-05, EMT and the program that preceded it, provided support for 113 graduate students including 31 women and 5 underrepresented minorities. Some examples of "nuggets" that represent activities addressing the PEOPLE goal include:

NSF Award 0432013 Information Processing in Biology
PI: Fred Roberts
Institution: Rutgers University
This activity supports a series of DIMACS short courses and workshops on aspects of biology involving the processing of information. In the period 6/6/05 – 5/5/06 there were 11 such short courses and workshops attended by a large number of students, postdoctoral fellows, and more senior researchers. Another 6 workshops are planned through 8/06.

NSF Award 0456720 Institute for Quantum Information
PI: John Preskill
Institution: California Institute of Technology
The Institute for Quantum Information, IQI, succeeds in attracting some of the best students and postdocs in the field. To date, they have trained 20 IQI Postdocs had long term visits from 12 researchers and short term visits from 50 graduate students. IQI serves as a foci for quantum information science and supports summer schools with components in quantum computation.

NSF Award 0448658 CAREER: Realistic Models and Simulations of Systems for Quantum Information Processing
PI Name: Todd Brun
Institution: University of Southern California
Development of software tools for simulating noisy quantum systems.

NSF Award 0449117 CAREER: Evolution of Signaling Mechanisms in Membrane Receptors
PI: Judith Klein
Institution: University of Pittsburgh
Understand the dynamic processes of folding and signal transduction in membrane proteins

NSF Award 0448835 CAREER: Engineering Nucleic Acid Devices
PI: Niles Pierce
Institution: California Institute of Technology
Discover methods of encoding mechanical function into nuclear acid structure.

B.2 OUTCOME GOAL for IDEAS: Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."

Comments: Some examples of "nuggets" that represent activities addressing the IDEAS goal include:

NSF Award 0130828 Biological Information Technology Systems - BITS: Information Processing in Designed Neuronal Circuits
PI: Bruce Wheeler
Institution: University of Illinois at Urbana-Champaign
This project is attempting to understand basic information processing in brain via designed neuronal circuits. This project is a collaboration between researchers from two disciplines - Computer science/Electrical engineering and Medical school

NSF Award 0217884 CRCNS: Collaborative Research: How is Information Coded in Turtle Visual Cortex?
PI: Kay Robbins
Institution: University of Texas at San Antonio
This collaborative project focuses on understanding the fundamental representation and processing of information in the turtle visual cortex.

NSF Awards 0432070/0432094 EMT: Rational Design of Synthetic Gene Networks using Formal Analysis of Hybrid Systems
PI: Calin A. Belta
Institution Name: Boston University
This project brings together a control theorist and a molecular biologist with the goal of developing hybrid system (discrete plus continuous dynamic) abstractions and synthesis techniques for novel genetic networks.

NSF Awards 0524837/0524838 QnTM: Collaborative Research: Quantum Algorithms
PI: Umesh Vazirani
Institute: University of California – Berkeley
PI: Leonard Schulman
Institution: California Institute of Technology
This project explores three of the most significant challenges in Quantum Computing, the hidden subgroup problem, algorithmic cooling, and fault-tolerant quantum computation.

B.3 <u>OUTCOME GOAL for TOOLS:</u> Providing "broadly accessible, state-of-the-art S&E facilities, tools and other infrastructure that enable discovery, learning and innovation."

Comments: The EMT cluster did not emphasize "tool development," example "nugge" that represent activities addressing the TOOLS goal are:

NSF 052375 QnTM: Tools for Distributed Quantum Information Processing
PI: Prem Kumar
Institution: Northwestern University
This project aims to develop prototype tools for distributed quantum information processing, QIP. These tools will be useful for fiber-based quantum logic and enable the development of optical based QIP.

NSF Award 0448658 CAREER: Realistic Models and Simulations of Systems for Quantum Information Processing

PI: Todd Brun
Institution: University of Southern California
Development of software tools for simulating noisy quantum systems.

B.4 <u>OUTCOME GOAL for ORGANIZATIONAL EXCELLENCE</u>: Providing "an agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices."[14]

Comments:
The EMT subcommittee found the program managers in the EMT cluster to be very proactive in forming panels and getting ad hoc reviews in a multi-disciplinary, non-conventional research area. The Program Director has also done an excellent job in reaching out to traditional communities and soliciting novel, interdisciplinary proposals. Given the nature of this area, the EMT subcommittee was particularly impressed by the efficiency with which panels were formed and proposals were ranked.

PART C. OTHER TOPICS

C.1 Program areas in need of improvement or gaps (if any) within program areas.

Whereas the program is interdisciplinary and addressing an important area, there are important opportunities within this area that may not be adequately emphasized. For example, there are critical research problems at the interfaces of quantum computing and condensed matter physics that are not being captured by this program. Similarly, proposals addressing problems at the intersection of biology and computer science may be perceived as being too biological by EMT (and too computer science centric by the BIO directorate)—creating a potential funding gap for important research.

C.2 The program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

EMT is a unique program. It integrates novel technologies with new models of computation. Because it is closely connected to advances in technologies, proposals in this area often require significant support in terms of laboratory experimentation and prototyping. The COV noted that the budgets for EMT grants (at approximately 100K/year) are bigger than grants in other programs in CCF. However, the budgets need to be significantly larger overall for EMT to be successful. Importantly, there must be a mechanism for significant investment in the most promising new research to move it into a truly experimental phase.

C.3 Agency-wide issues that should be addressed by NSF to help improve the program's performance.

EMT brings physicists, biologists, chemists, engineers, mathematicians and computer scientists together. EMT researchers come from different communities and are often funded by diverse

[14] For examples and further detail on the Organizational Excellence Goal, please refer to pp. 19-21 of NSF's Strategic Plan, FY 2003-2008, at <http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf04201>.

funding agencies (NIH, DOE, DoD). It may be useful to examine other models for processing proposals, models that EMT researchers are used to working with. The EMT subcommittee debated the merits of (a) employing a panel that includes standing members along with rotating members to bring “memory” to the review system; and (b) sending out summary statements to the PIs soon after the panel before waiting for the funding decisions (similar to the current NIH system).

C.4 Comments on any other issues the COV feels are relevant.

C.5 Comments on how to improve the COV review process, format and report template.

There are certain questions in this template for which the COV work would be expedited if NSF could have the data ready when the COV arrives. Examples include data to support questions A.1.6, A.3.3, A.4.6, A.4.7, A.4.8, and A.4.11. The EMT subcommittee was particularly concerned about the lack of data on geographical, institutional and ethnic/gender distribution of reviewers and proposers. These data should be made available in advance of the meeting.

The e-Jacket system made it difficult to obtain immediate access to additional (not selected in advance by the Division) jackets, as each had to be entered individually by Division staff. It would be useful to have an orientation meeting (by teleconference) and to allow the COV access to real or model e-Jacket data in advance of the actual COV meeting. A great deal of time was spent familiarized the COV members with the NSF on-line systems.

SIGNATURE BLOCK:

____

For the Emerging Models and Technologies for Computation Cluster Subcommittee
2006 Computing and Communications Foundations Division COV
Dr. W. Richards Adrion
Co-Chair for the Emerging Models and Technologies for Computation Cluster Subcommittee
Dr. Mary Jean Harrold
Chair 2006 Computing and Communications Foundations Division COV

-FY 2006 REPORT FOR
NSF COMMITTEES OF VISITORS (COVs)
Theoretical Foundations Cluster (TF)

.

Date of COV: June 15-16, 2006
Program/Cluster/Section: Theoretical Foundations (TF) Cluster
Division: Computing & Communication Foundations
Directorate: Computer Information, Science and Engineering (CISE)
Number of actions reviewed: Awards: 22 Declinations: 84 Other:
Total number of actions within Program/Cluster/Division during period under review: **Awards: 370 Declinations: 1196 Other: 64**
Manner in which reviewed actions were selected: The 106 actions reviewed were selected randomly by CCF personnel.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Part A discusses and provides comments for each relevant aspect of the program's review process and management. Comments are based on the TF subcommittee's review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Comments are provided for each program reviewed and for those questions that were relevant to the program under review. Quantitative information was not available for all questions. In these cases, "Data Not Available" is indicated in the right hand column of the tables below. Constructive comments noting areas in need of improvement are provided as well.

A.1 Quality and effectiveness of the program's use of merit review procedures.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCEDURES	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE [15]
1. Is the review mechanism appropriate? (panels, ad hoc reviews, site visits) Comments: Most proposals are reviewed by panels. Each proposal is usually reviewed prior to the panel meeting by 3 or 4 panelists and then is discussed by the panel members, and a panel report summarizing the consensus is written.	Yes

[15] If "Not Applicable" please explain why in the "Comments" section.

The panels include a mix of younger and more senior members. There is some concern that the individual reviews produced by the panel mechanism are inadequate; see A.1.3. A few proposals are reviewed by the classical mechanism of mail reviews.	
2. Is the review process efficient and effective? Comments: The process of obtaining individual written reviews by 3 or 4 panel members prior to the panel meeting followed by the panel discussion of each proposal works well most of the time. It has led to a significant reduction of the time to decision with respect to the previous 3-year period; it now stands at 4 to 5 months for most of the proposals.	Yes
3. Do the individual reviews (either mail or panel) provide sufficient information for the principal investigator(s) to understand the basis for the reviewer's recommendation? Comments: The information content of the individual reviews is mixed. Some reviews are extensive and authoritative, but roughly one third are uninformative. In some of these cases, the reviewers are not knowledgeable about the subject matter. In other cases, a heavy reviewing load may be responsible for the perfunctory nature of the reviews. Based on our limited sample of proposals, this seemed to be less of a problem in Communications and Signal Processing panels. In general, the mail reviews are more thorough than the panel reviews.	Not always
4. Do the panel summaries provide sufficient information for the principal investigator(s) to understand the basis for the panel recommendation? Comments: Many of the panel summaries provided information that would help the PI to understand why the panel made its recommendation, but in other cases the panel summary was either terse or uninformative. NSF has an obligation to provide feedback that will help unsuccessful PIs prepare a better proposal next time. The TF subcommittee urges Program Directors to ask, as a matter of policy, that panel summaries include constructive comments for unsuccessful proposals. The review summaries written by the Program Directors were generally excellent, containing a clear summary of the panel's overall view of the proposal and the rationale for funding/not funding. In cases where the panel summary and the reviews do not provide enough guidance to the investigator, direct feedback from the Program Director would be beneficial.	Not always
5. Is the documentation for recommendations complete, and does the program officer provide sufficient information and justification for her/his recommendation? Comments: The database kept by NSF on recommendations is comprehensive and well organized. Almost all recommendations by the Program Director were	Yes

in agreement with the panelist recommendations. In the cases where the two recommendations differed, the Program Director usually included a well-reasoned explanation for his or her recommendation. In a few cases, the Program Director's comments were not available in the database. In a very few cases, the offered explanation did not seem adequate, for example, a recommendation to decline a highly-competitive proposal. In such cases, program directors should strive to explain the basis for recommendations.	
6. Is the time to decision appropriate? Comments: Most of the proposals in this period were reviewed in 4 to 5 months, which is a significant improvement over the 9 to 12 months that were the norm a few years ago.	Yes
7. Additional comments on the quality and effectiveness of the program's use of merit review procedures: As mentioned by one unhappy panelist and experienced by four TF subcommittee members, in some panels, the panelists were asked to adjust the ratings of their reviews to align them with panel recommendations. The TF subcommittee views this practice as inappropriate. The Program Directors should ensure that the reviewers have a consistent understanding of the meaning of the ratings before the reviewers submit their individual reviews.	

A.2 Implementation of the NSF Merit Review Criteria (intellectual merit and broader impacts) by reviewers and program officers.

IMPLEMENTATION OF NSF MERIT REVIEW CRITERIA	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE [16]
1. Have the individual reviews (either mail or panel) addressed both merit review criteria? Comments: The record here is somewhat mixed. Some reviewers do not address these criteria explicitly, and others give very cursory statements in their responses. These problems are more noticeable for the broader-impacts criterion, where the comments (when they are given) are quite generic and often do not really address the issue of broader impact. Some address fairly technical things here, even though they should more properly address broader educational and societal issues.	Not always
2. Have the panel summaries addressed both merit review criteria? Comments: Panel summaries tend to be better than individual reviews at addressing these criteria, although they are still handled cursorily in many cases.	Yes
3. Have the *review analyses* (Form 7s) addressed both merit review criteria? Comments: Here the statements, although still somewhat brief, address the criteria directly in most cases.	Yes
4. Additional comments with respect to implementation of NSF's merit review criteria: It might be helpful to find ways to clarify the broader-impacts criterion, perhaps by giving examples. Although these do appear on the NSF website, more useful information might be obtained from the reviewers and panelists if these were discussed with the panel members more explicitly. The reviewers' statements of impact should have a more specific focus over and above the universal objective of training graduate students.	

[16] In "Not Applicable" please explain why in the "Comments" section.

A.3 Selection of reviewers.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE [17]
1. Did the program make use of an adequate number of reviewers? Comments: Each proposal received an adequate number of reviews—at least three and in some cases five or six. The average load per reviewer for panelists seems tolerable but heavy and should not be increased.	Yes
2. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: The situation seemed to vary by area/program. For example, the reviewer assignments for the proposals in signal processing and communications seemed for the most part to be appropriate. However, in some cases the reviewers in theoretical foundations lacked the appropriate expertise, perhaps because the panels covered too broad a spectrum.	Not always
3. Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups?[18] Comments: The geographic distribution of reviewers was representative of the entire country. The reviewers came from a wide range of universities and smaller teaching institutions. There were very few reviewers from outside academia. We could not ascertain whether minority groups were well enough represented.	Yes
4. Did the program recognize and resolve conflicts of interest when appropriate? Comments: As far as we can tell from the individual experience of COV members participation in review panels, the Program Directors are very sensitive to the conflict of interest issues and take great care to avoid them.	Yes
5. Additional comments on reviewer selection: Reviewers should be asked to rate their own expertise and confidence with respect to each proposal. This will aid the panel discussion and assist the Program Directors in making evaluations in cases where some of the reviews are less authoritative. These self-evaluations should not be	

[17] If “Not Applicable” please explain why in the “Comments” section.
[18] Please note that less than 35 percent of reviewers report their demographics last fiscal year, so the data may be limited.

sent to the PIs.

A.4 Portfolio of awards under review.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[19], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: The TF subcommittee was impressed by the outstanding quality of the projects funded by the TF cluster, but was also impressed by the outstanding quality of the many proposals that are not funded. It is disturbing to see so much high-quality research that cannot be funded. This subcommittee hopes that increased NSF budgets in the future will help to alleviate this problem.	Yes
2. Are awards appropriate in size and duration for the scope of the projects? Comments: In the case of theory of computing, the awards were typically about $ 70,000 per year. This was a deliberate policy aimed at sharing the limited resources as widely as possible. However, a $70,000 per year award is not sufficient to support a researcher and one student. As a consequence, Theory of Computing investigators often submitted multiple proposals to NSF, undesirably increasing the load on them and the review process. The problem of too small awards is less severe in other areas because fewer proposals were awarded.	Not always
3. Does the program portfolio have an appropriate balance of: • Innovative/high-risk projects?[20] Comments: As reported in the 2005 Report of the Advisory Committee for GPRA Performance Assessment, previous NSF COVs mentioned: (1) that the concept of "risk" and the characteristics of a risky proposal need to be clarified, (2) that funded proposals appear to be the more conservative ones, and (3) that the consensus required of panels may overlook or deemphasize high-risk, high-potential projects. The GPRA report also commented on the difficulty of applying the NSF definitions of "innovative/high-risk" projects, noting that some research could have very high reward but also low risk. Various members of the TF subcommittee expressed agreement with these	Yes

[19] If "Not Appropriate" please explain why in the "Comments" section.
[20] For examples and concepts of high risk and innovation, please see Appendix III, p. 66 of the Report of the Advisory Committee for GPRA Performance Assessment, available at <www.nsf.gov/about/performance/acgpa/reports.jsp>.

points. The portfolio of active proposals represented an array of top-quality research conducted by outstanding scientists. Hence the TF subcommittee has no concerns about quality, but it is doubtful that a creative proposal by an outstanding scientist could be considered as "risky," since the person is likely to produce excellent results in any case. In the selection of jackets that the subcommittee reviewed, there were instances in which proposals were not funded because panel members commented that the research was interesting and important, but were not convinced that the research would succeed. Although this kind of result might seem to demonstrate an aversion to risk, the subcommittee's interpretation is that it is a reasonable response to the extremely limited available funding. In fact, for some panels it was explicitly stated that proposals needed to meet an "exceedingly high" standard, which these did not. If NSF is serious about funding high-risk research in a severely constrained funding environment, this criterion (along with a clearer definition) should be stressed in the instructions to panels, which could be asked to identify such proposals if they are not funded. An internal NSF mechanism could then be created to evaluate such proposals separately.	
4. Does the program portfolio have an appropriate balance of: • Multidisciplinary projects? Comments: During the three-year period covered by this COV, almost all of the multidisciplinary projects in the TF portfolio were either ITR projects (which are, by definition, multidisciplinary) or "collaborative research" projects. Because ITR funding has now ended, the TF subcommittee is very concerned about how multidisciplinary research in TF areas will be covered within CISE in the future.	Yes
5. Does the program portfolio have an appropriate balance of: • Funding for centers, groups and awards to individuals? Comments: The program funds one Science and Technology Center, CENS at UCLA. A significant fraction of the TF budget is for CAREER awards.	Yes
6. Does the program portfolio have an appropriate balance of: • Awards to new investigators? Comments: Given the current restrictions, the balance of awards to new and returning investigators is appropriate. Some Program Directors have been especially proactive in selecting promising proposals from new investigators and offering modest funding for shorter-term exploratory grants. This practice should be encouraged and expanded. In addition, the TF subcommittee recommends complementing the highly selective CAREER program with a resurrected Research Initiation Award program. This program would provide smaller and shorter-term awards for promising new investigators.	Yes

7. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: While there are some states/regions that receive more awards than others, they also have significantly more submissions and the award rate for proposals from those regions is lower than for proposals from other regions.	Yes
8. Does the program portfolio have an appropriate balance of: • Institutional types? Comments: Most of the awards are made to researchers at major research institutions. This is appropriate given the higher level of research activity and emphasis on advanced training at these institutions. One way for faculty and students at different types of institutions to participate in research is through collaborations with major research institutions. It is difficult to determine from the data available if there are many of these types of collaborations going on. If these types of collaborations are common, then that is good. If not, then it would be good to encourage them.	Yes
9. Does the program portfolio have an appropriate balance of: • Projects that integrate research and education? Comments: The focus of the awards is on research and supporting graduate students, which in itself is an educational component. In CISE a very high priority is given to supporting REU supplementary awards.	Yes
10. Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity and of emerging opportunities? Comments: Within TF the balance is appropriate, but the overall support for TF within CISE is significantly less than proportional to its scientific importance.	Yes
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: Over the three year period 2003-2005, the percentages of submitted proposals that were awarded were 21.5% (overall), 12.8% (minority PIs), 24.8% (female PIs). The award rate for the minority PI proposals is 60% of the average award rate, but decisions appear to have been made fairly. To answer this question more fully, the subcommittee would need data that compare success rates of investigators from	No data available

underrepresented groups with those from majority group investigators of the same institution.	
12. Is the program relevant to national priorities, agency mission, relevant fields and other customer needs? Include citations of relevant external reports. Comments: In the judgment of the TF subcommittee, the program portfolio adequately covers the range of research areas addressed by the TF cluster within CCF. The research funded in this portfolio will provide the foundations for many of the future IT needs of the nation.	Yes
13. Additional comments on the quality of the projects or the balance of the portfolio: NSF needs to be aware of the trend for reduced industry and government funding in the areas covered by TF and to develop a long term plan to assure adequate research funding in these areas.	

A.5 Management of the program under review

1. Management of the program. Comments: The leaders of CCF face a difficult balancing act as new trends in the field develop and resources fluctuate. They approach the allocation of resources systematically and skillfully. There is good cooperation among the Program Directors.
2. Responsiveness of the program to emerging research and education opportunities. Comments: The program seeks advice from the overall CISE advisory committee. Program Officers are clearly willing to take the initiative in organizing workshops as new research areas and perspectives emerge; there were an adequate number of and variety of exploratory research workshops sponsored by this cluster.
3. Program planning and prioritization process (internal and external) that guided the development of the portfolio. Comments: The program planning and prioritization process is rational but may suffer from anomalies in the cluster structure, which needs revision. The combination of fixed allocations to the Program Directors combined with a shared cluster reserve provides needed flexibility in dealing with changing trends and new initiatives.
4. Additional comments on program management:

PART B. RESULTS OF NSF INVESTMENTS

B. Comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes (nuggets) as appropriate.

B.1 <u>OUTCOME GOAL for PEOPLE</u>: Developing "a diverse, competitive and globally engaged workforce of scientists, engineers, technologists and well-prepared citizens."

Comments: The majority of funding from TF goes to support Ph.D. students in the areas of signal processing, communications, and theory of computing. TF also supports numerous undergraduates as REU students, often giving them their first research experience in these areas.

B.2 <u>OUTCOME GOAL for IDEAS</u>: Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."

Comments:
The following list of "nuggets" represents a selection of the research outcomes supported by TF that the COV regarded as significant.

NSF Award 0219438 Optimization of Systems Governed by Partial Differential Equations
PI: Jorge Nocedal
Institution: Northwestern University
Optimization of very large scale systems (with millions of variables) defined by nonlinear partial differential equations has recently become an area of great interest in several applications. This research is notable because the work has produced enlightening new theoretical analyses of partial differential equations and the convergence of optimization methods, as well as design of a numerical software framework for solving ODE-constrained optimization problems on massively parallel computers.

NSF Award 0306382 Games for Formal Design and Verification of Reactive Systems
PI: Rajeev Alur
Institution: University of Pennsylvania
In recent years, model checking has become an important tool for analyzing and verifying complex software systems. Alur's research has shown how game theory can be used to study open software systems, and specifically that the abstraction of games can capture software requirements that represent environment assumptions.

Three of the 160 discoveries displayed on the NSF website have their origins in the TF cluster. Two are listed here:

NSF Awards 0073489,0073490, 9875511 From Moonbounce to Hard Drives: Correcting More Errors Than Previously Thought Possible
PIs: R. Koetter and Alexander Vardy
http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=100256
What does a Nobel laureate need to bounce a radio signal off the moon? A good error-correcting code, for one thing. Now, a breakthrough error-correction method has turned almost 40 years of conventional wisdom in digital communications on its head.

NSF Award 9973012 Getting a Message Across the Universe: Would E.T. Send a Letter? Snail mail from outer space
PIs: Christopher Rose and Roy Yates
http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=106711

NSF Award 9730556 Fundamental Experimental and Analytical Studies in Ultra Wideband Radio With Application to Wireless Multimedia Communication
PI: Robert Scholtz
Institution: University of Southern California
This work uses Ultrawideband (UWB) array processing techniques to give a fresh look a characterizing UWB propagation. It is based on arrays of indoor time-domain measurements made by Moe Win. Jean-Marc Cramer processed these using a version of the CLEAN algorithm that was modified for array processing applications. The result was a UWB channel model that characterized UWB indoor multipath propagation in terms of angle of arrival, time of arrival, and signal amplitude. Clustering parameters were developed that may be applied to models of the measurement environment (a lab/office building). This work was supplied to the IEEE 802.15.3 task force charged with UWB channel model development.

This work is notable because:
This work describes an experimental technique for array processing of UWB (impulse) propagation measurements that leads to useful UWB channel characterizations for UWB radio design. A paper on this work won the 2003 Sergei Schelkunoff Prize Paper Award given by the IEEE Antennas and Propagation Society.

NSF Award 9903368 Over-complete Signal Decomposition
PI: Avideh Zakhor
Institution: University of California-Berkeley
Matching Pursuit is an algorithm that represents any signal as a linear combination of waveforms chosen from a redundant dictionary of functions, where the particular waveforms used in the representation are chosen to best match the signal structures. A Matching Pursuits-based video compression-decompression algorithm or codec, developed under NSF Grant #9903368, is now in use for some video streaming applications over three U.S. Carriers: Verizon Wireless (the U.S. Carrier with the largest number of subscribers), U.S. Cell, and AllTel. Some major content owners such as Disney are using this technology for streaming video over these wireless carriers. The latter technology is provided by Truevideo (see Truevideo), a Berkeley startup founded by the PI.

This work is notable because:
This is a compelling example of how very theoretical research, conducted in a academic institution, can transition into the marketplace and have significant economic impact.

This work involves innovative, risky, or multi-disciplinary research:
There were no guarantees that their new approach would even achieve parity with contemporary ones.

NSF Award 9873670 CAREER—Intelligent PDE's: Introducing Knowledge into Geometry Driven Image Deformations
PI: Guillermo Sapiro
Institution: University of Minnesota-Twin Cities
Well over half the bits transmitted from the Mars Exploration Rovers (MER) that have landed on Mars (Spirit and Opportunity Rovers) will consist of compressed image data gathered from the unprecedented nine cameras on-board each of two rovers. This compression is based on the ICER

and the LOCO image compression technologies. LOCO was developed by Dr. Marcelo Weinberger and Dr. Gadiel Seroussi from Hewlett-Packard Laboratories and NSF supported Prof. Guillermo Sapiro from the Electrical and Computer Engineering Department at the University of Minnesota. The JPL/NASA hardware implementation of LOCO on-board the rovers is used when maximum geometric and radiometric fidelity is required. LOCO is based on concepts such as context modeling and Golomb-encoding, which have been extended and combined to produce state-of-the-art compression at very low complexity. The LOCO technology, patented by Sapiro, Seroussi, and Weinberger at Hewlett-Packard Laboratories, is also the core of the international standard JPEG-LS for the lossless and near-lossless compression of still images. The images presented in MarsRovers were all done with the above techniques, and chronicle the entry, descent, and landing of the first rover (meaning some of the first images NASA received from Mars).

This work is notable because:
Everyone has seen the images (cnn.com or nasa.gov), significantly enhancing the visibility of science (the particular contribution of LOCO to this expedition has received coverage in the domestic and international press). Their compression algorithm was independently selected and adopted by others (JPL/NASA), not just by the developers, due to its merits such as state-of-the-art compression results at extremely low computational complexity.

This work involves innovative, risky, or multi-disciplinary research:
This work lies at the intersection of mathematics, communication, and image processing.

NSF Award 0073520 Theory and Algorithms for Robust Information Embedding
PI: Gregory Wornell
Institution: Massachusetts Institute of Technology
Fundamental research on information embedding (data hiding) has led to the development of Quantization Index Modulation (QIM), the first practical capacity-approaching information embedding codes. QIM formed the basis of the development of the first industrial real-time information embedding system. The field-testable commercial-grade prototype transparently embeds 6 Mb/s of arbitrary data into an analog (NTSC) television signal. This translates to roughly 300 Mb/s of free additional downstream bandwidth in an FCC-compliant cable plant, without requiring plant upgrades or disrupting existing services. The core of the prototype is a 400,000 gate QIM FPGA codec. Such technology may play an important role in enabling the wide-scale deployment of advanced bandwidth-hungry services in the future, such as video-on-demand and interactive television.

This work is notable because:
It demonstrates how fundamental research can lead to radically new algorithmic approaches to solving difficult problems like the last-mile bandwidth bottleneck.

NSF Awards 9820604, 9902846 Broadband Wireless ATM Local Loop Using Millimeter Wave-Band
PI: Mohsen Kavehrad
Institution: Pennsylvania State University, University Park
Wireless infrared local-area networking is a flexible and economical alternative to hardwired interconnections. Unlike radio frequency transmission, both narrow- and wide-angle infrared communications can support high data rates, but at a cost. Narrow-angle transmission requires precise alignment of transmitter and receiver, while wide-angle transmission demands high power.

Mohsen Kavehrad and Svetla Jivkova, researchers at Pennsylvania State University in University Park, have illustrated a model that combines elements of both narrow- and wide-angle systems to deliver high data rates with low power. Prototype components have been constructed, and Kavehrad plans to demonstrate a system prototype. Data rates of hundreds of megabits per second are achievable with a transmitter that consumes well under 1 W. This breakthrough research has received extensive coverage in the news media, including articles in the New York Times , the Science Daily Magazine, the EE Times US and UK , and Laser Focus World .

This work is notable because:
This work demonstrates how novel approaches to real-world problems can provide new capabilities, resulting in the transfer of academic research to commercial products.

NSF Award 0244647 CAREER: Research and Education in Video Coding and Wireless Communications
PI: Maja Bystrom
Institution: Boston University
A team of undergraduate students working with Maja Bystrom has developed a graphical, three-dimensional file manager which has won first place in the Illustration Category of the NSF and AAAS Science "Science and Engineering Visualization Challenge". The file manager uses colors to indicate links between files and directories, and is designed to assist users in managing complex personal file systems and in traversing their file systems in an efficient and intuitive manner. A description of the award and a screen snapshot of the file manager can be found in Science, vol. 301, No. 5639, p. 1476, Sept. 2003.

This work is notable because:
This is an excellent example of the dedication shown by a CAREER awardee to the education mission of NSF.

B.3 <u>OUTCOME GOAL for TOOLS:</u> Providing "broadly accessible, state-of-the-art S&E facilities, tools and other infrastructure that enable discovery, learning and innovation."

Comments: The following list of "nuggets" represents a selection of the research outcomes supported by TF that the COV regarded as significant.

NSF Award 0203270 Sparse Matrix Algorithms and their Applications to Dual Active Set Techniques in Optimization
PI: Timothy Davis
Institution: University of Florida
The goal of this project was to develop innovative numerical methods and library-quality publicly available software to solve an important class of constrained optimization problem. The outcome was a collection of software that uses state-of-the-art sparse matrix techniques and has successfully solved state-constrained control problems. The software is documented at the following Website, from which it may be downloaded: www.cise.ufl.edu/research/sparse.

NSF Award 093343 Simulation of Lighting and Acoustics in Interactive Visual Environments
PI: Thomas Funkhouser
Institution: Princeton University
This project has been central in a group activity in the Computer Science Department at Princeton.

The research has investigated mathematical and computational issues in shape-based retrieval and analysis of 3D models; the major research issues are development of shape representations and query interfaces. For further details, see www.cs.princeton.edu/gfx/proj/shape.

B.4 OUTCOME GOAL for ORGANIZATIONAL EXCELLENCE: Providing "an agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices."[21]

Comments: The TF Cluster tries very hard to consult widely with the scientific community in order to anticipate trends in the field and keep its programmatic goals relevant. The Cluster reserve mechanism is an effective tool for rapidly adapting to opportunities and changing trends.

PART C. OTHER TOPICS

C.1 Please comment on any program areas in need of improvement or gaps (if any) within program areas.

The advent of the Worldwide Web and the Internet has created an environment for computing which is simultaneously a social system, an economic system, a communication system, and a computation system. Issues of security, privacy, reliability, contention for resources, and information retrieval need to be re-examined in light of this. CCF is a natural home for foundational work in all these areas, which will also be pursued at the applied level in other divisions and potentially through GENI.

Computer science is becoming central in all organized areas of knowledge, not only by providing tools but also methods of data organization, modeling and information extraction. In addition, the subject matter of computer science has become entangled with areas such as quantum mechanics through the areas of quantum computing, with biology with cells regarded as computational devices, with statistical physics through a shared interest in phase transitions, and with the social sciences through the systemic study of social networks. This suggests that CCF should develop cross-directorate programs to develop these connections.

C.2 Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

The distribution of faculty in research departments, and in particular the pattern of new faculty hires by area, gives an indication of how the academic community assesses the relative importance of different areas. Using this yardstick as a measure, the foundational areas of computing, communication, and signal processsing are underfunded by CISE. While we recognize that mandated programs and programmatic commitments must enter the funding equation, we urge creation of a mechanism that allows the broader academic community to express its views on funding priorities to CISE.

C.3 Agency-wide issues that should be addressed by NSF to help improve the program's performance.

[21] For examples and further detail on the Organizational Excellence Goal, please refer to pp. 19-21 of NSF's Strategic Plan, FY 2003-2008, at <http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf04201>.

The ITR program has been the principal driver of multi-disciplinary research within CISE and even across Directorates. Unless ITR is continued or a broad-based program of comparable scale is created to replace it, the responsibility of multi-disciplinary research will fall on CISE, which has neither the funding nor the management capacity to handle it.

CCF/CISE/NSF should develop additional mechanisms for evaluation of its performance. This would require development of databases for tracking publication records, patents, etc., and career paths of funded students and investigators. The project annual reports already request some of this information, but not in a format that can be reported easily.

There is concern that near term basic research (3-5 years) in wireless communications systems in the USA is lagging behind that of Europe and Asia. This problem should be addressed at the NSF-wide level. CCF/CISE should consider taking a more active role in the allocation of NSF graduate fellowships by assisting the EHR Directorate in the review process.

C.4 Comments on other issues the COV feels are relevant.

CCF should take a more active role in informing the public of the results of its research investment by publishing accessible explanations of research results. Each project should provide a nugget in each of its annual reports and CCF should select the best of these to be publicized through expository articles and distributed through the web. CCF should publicize the most significant research achievements in an annual report that could inform the public and excite potential students about the field.

While the panel review process is good in general, CISE might consider modifying the model to have panelists commit to serving on multiple, consecutive panels in a particular area. This would help to make decisions more consistent.

C.5 NSF would appreciate your comments on how to improve the COV review process, format and report template.

For future reference, CCF should go over all the questions asked in the COV report and prepare the data and statistics needed to answer them.

COV should have access to all the awarded proposals.

The outcome component of the COV evaluation report should be based on a review of the final reports of the projects that have ended during the evaluation period. The COV should have access to the final and progress reports for these projects as well as the progress reports of active projects.

SIGNATURE BLOCK:

____

For the Theoretical Foundations Cluster Subcommittee
2006 Computing and Communications Foundations Division COV
Dr. José M. F. Moura
Co-Chair for the Theoretical Foundations Cluster Subcommittee
Dr. Mary Jean Harrold
Chair 2006 Computing and Communications Foundations Division COV

Section 3
Appendices

Appendix 1: Agenda

Thursday, June 15th

8:30-9:00 AM	Sign-In and Continental Breakfast Room - 380
9:00-9:15 AM	CISE Assistant Director Welcoming Remarks (Peter Freeman)
9:15-10:00 AM	CCF Division Director Welcoming Remarks (Mike Foster) CCF Cluster Reconstruction Division Conflict of Interest Briefing
10:00-10:15	COV Chair Welcoming Remarks (Mary Jean Harrold)
10:15-10:30	General Question & Answers
10:30-10:45	Break-out Rooms Room 320 - TF Cluster Room 330 - CPA Cluster Room 370 - EMT Cluster
10:45:11:00	Program Directors Overview (COV Cluster Rooms)
11:00-11:15	E-Jacket Overview (Support Staff)
12:00 PM	Working Lunch (Catered)
1:00 PM	Begin COV Award/Decline Review
3:00 PM	Break
3:15 PM	Continue COV Award/Decline Review
5:00-5:15 PM 05:30 PM	Meet Ground Floor of Stafford I Building- North Lobby Dinner for COV Members and NSF Staff (Westin's Pinzimini Restaurant)

Friday, June 16th

8:30 AM	Continental Breakfast Room 380
9:00 AM	Begin COV Award/Decline Review Break-out Rooms
10:30 AM	Break
10:45 AM	Continue COV Award/Decline Review
12:00 PM	Working Lunch (Catered)
1:00 PM	Begin Formulating Recommendations Room 380
2:15-2:30 PM	Break
2:30-3:30 PM	Begin Drafting Report
3:30-4:00 PM	Executive Session with Division Director, COV Chair, Co Chair, AC Rep and Business Operation Manager
4:00:4:30 PM	Drafting COV Report
4:30-5:00 PM	Complete and Submit COV report (Peter Freeman and Executives)

Adjourn

Appendix 2: COV Members

Name	Institution	Email
COV Chair Dr. Mary Jean Harrold	Georgia Institute of Technology	harrold@cc.gatech.edu
Computing Processes & Artifacts (CPA)		
Dr. Annie Antón	North Carolina State University	aianton@ncsu.edu
Dr. Arvind	Massachusetts Institute of Technology	Arvind@mit.edu
Dr. Ronald (Shawn) Blanton	Carnegie-Mellon University	blanton@ece.cmu.edu
Dr. Ralph Cavin (Chair)	Semiconductor Research Corporation	cavin@src.org
Dr. Anthony Finkelstein	University College London	a.finkelstein@cs.ucl.ac.uk
Dr. John Knight	University of Virginia Main Campus	knight@cs.virginia.edu
Dr. James (Jim) Thomas	Pacific Northwest National Laboratory	Jim.Thomas@pnl.gov
Emerging Models & Technology for Computation		
Dr. W. Richards Adrion (Chair)	University of Massachusetts Amherst	adrion@cs.umass.edu
Dr. David Cory	Massachusetts Institute of Technology	dcory@mit.edu
Dr. Vijay Kumar	University of Pennsylvania	kumar@central.cis.upenn.edu
Dr. Martin Tompa	University of Washington	Tompa@cs.washington.edu
Theoretical Foundations (TF)		
Dr. Nancy Amato	Texas A&M University	amato@cs.tamu.edu
Dr. Steven Fortune	Lucent Technologies, Bell Labs	sjf@lucent.com
Dr. Bruce Hajek	University of Illinois at Urbana-Champaign	b-hajek@uiuc.edu
Dr. Richard Karp	University of California-Berkeley	karp@icsi.berkeley.edu
Dr. José Moura (Chair)	Carnegie-Mellon University	moura@ece.cmu.edu
Dr. Harold (Vince) Poor	Princeton University	poor@ee.princeton.edu
Dr. Diane Souvaine	Tufts University	dls@cs.tufts.edu
Dr. Margaret Wright	New York University	mhw@cs.nyu.edu

Appendix 3: Report Template

CORE QUESTIONS and REPORT TEMPLATE
for
FY 2006 NSF COMMITTEE OF VISITOR (COV) REVIEWS

Guidance to NSF Staff: This document includes the FY 2006 set of Core Questions and the COV Report Template for use by NSF staff when preparing and conducting COVs during FY 2006. Specific guidance for NSF staff describing the COV review process is described in Subchapter 300-Committee of Visitors Reviews (NSF Manual 1, Section VIII) that can be obtained at <www.inside.nsf.gov/od/oia/cov>.

NSF relies on the judgment of external experts to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. Committee of Visitor (COV) reviews provide NSF with external expert judgments in two areas: (1) assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions; and (2) comments on how the results generated by awardees have contributed to the attainment of NSF's mission and strategic outcome goals.

Many of the Core Questions are derived from NSF performance goals and apply to the portfolio of activities represented in the program(s) under review. The program(s) under review may include several subactivities as well as NSF-wide activities. The directorate or division may instruct the COV to provide answers addressing a cluster or group of programs – a portfolio of activities integrated as a whole – or to provide answers specific to the subactivities of the program, with the latter requiring more time but providing more detailed information.

The Division or Directorate may choose to add questions relevant to the activities under review. NSF staff should work with the COV members in advance of the meeting to provide them with the report template, organized background materials, and to identify questions/goals that apply to the program(s) under review.

Guidance to the COV: The COV report should provide a balanced assessment of NSF's performance in two primary areas: (A) the integrity and efficiency of the ***processes*** related to proposal review; and (B) the quality of the ***results*** of NSF's investments that appear over time. The COV also explores the relationships between award decisions and program/NSF-wide goals in order to determine the likelihood that the portfolio will lead to the desired results in the future. Discussions leading to answers for Part A of the Core Questions will require study of confidential material such as declined proposals and reviewer comments. *COV reports should not contain confidential material or specific information about declined proposals.* Discussions leading to answers for Part B of the Core Questions will involve study of non-confidential material such as results of NSF-funded projects. The reports generated by COVs are used in assessing agency progress in order to meet government-wide performance reporting requirements, and are made available to the public. Since material from COV reports is used in NSF performance reports, the COV report may be subject to an audit.

We encourage COV members to provide comments to NSF on how to improve in all areas, as well as suggestions for the COV process, format, and questions. For past COV reports, please see http://www.nsf.gov/od/oia/activities/cov/covs.jsp.

FY 2006 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV:
Program/Cluster/Section:
Division:
Directorate:
Number of actions reviewed: Awards: Declinations: Other:
Total number of actions within Program/Cluster/Division during period under review: **Awards: Declinations: Other:**
Manner in which reviewed actions were selected:

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review procedures. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCEDURES	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[22]
1. Is the review mechanism appropriate? (panels, ad hoc reviews, site visits) Comments:	

[22] If "Not Applicable" please explain why in the "Comments" section.

2. Is the review process efficient and effective? Comments:	
3. Do the individual reviews (either mail or panel) provide sufficient information for the principal investigator(s) to understand the basis for the reviewer's recommendation? Comments:	
4. Do the panel summaries provide sufficient information for the principal investigator(s) to understand the basis for the panel recommendation? Comments:	
5. Is the documentation for recommendations complete, and does the program officer provide sufficient information and justification for her/his recommendation? Comments:	
6. Is the time to decision appropriate? Comments:	
7. Additional comments on the quality and effectiveness of the program's use of merit review procedures:	

A.2 Questions concerning the implementation of the NSF Merit Review Criteria (<u>intellectual merit</u> and <u>broader impacts</u>) by reviewers and program officers.
Provide comments in the space below the question. Discuss issues or concerns in the space provided.

IMPLEMENTATION OF NSF MERIT REVIEW CRITERIA	YES, NO, **DATA NOT AVAILABLE, or NOT APPLICABLE**[23]
1. Have the individual reviews (either mail or panel) addressed both merit review criteria? Comments:	
2. Have the panel summaries addressed both merit review criteria? Comments:	
3. Have the *review analyses* (Form 7s) addressed both merit review criteria? Comments:	
4. Additional comments with respect to implementation of NSF's merit review criteria:	

[23] In "Not Applicable" please explain why in the "Comments" section.

A.3 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[24]
1. Did the program make use of an adequate number of reviewers? Comments:	
2. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments:	
3. Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups?[25] Comments:	
4. Did the program recognize and resolve conflicts of interest when appropriate? Comments:	
5. Additional comments on reviewer selection:	

[24] If "Not Applicable" please explain why in the "Comments" section.
[25] Please note that less than 35 percent of reviewers report their demographics last fiscal year, so the data may be limited.

A.4 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[26], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments:	
2. Are awards appropriate in size and duration for the scope of the projects? Comments:	
3. Does the program portfolio have an appropriate balance of: • Innovative/high-risk projects?[27] Comments:	
4. Does the program portfolio have an appropriate balance of: • Multidisciplinary projects? Comments:	
5. Does the program portfolio have an appropriate balance of: • Funding for centers, groups and awards to individuals? Comments:	
6. Does the program portfolio have an appropriate balance of: • Awards to new investigators? Comments:	

[26] If "Not Appropriate" please explain why in the "Comments" section.
[27] For examples and concepts of high risk and innovation, please see Appendix III, p. 66 of the Report of the Advisory Committee for GPRA Performance Assessment, available at <www.nsf.gov/about/performance/acgpa/reports.jsp>.

7. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments:	
8. Does the program portfolio have an appropriate balance of: • Institutional types? Comments:	
9. Does the program portfolio have an appropriate balance of: • Projects that integrate research and education? Comments:	
10. Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity and of emerging opportunities? Comments:	
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments:	
12. Is the program relevant to national priorities, agency mission, relevant fields and other customer needs? Include citations of relevant external reports. Comments:	
13. Additional comments on the quality of the projects or the balance of the portfolio:	

A.5 Management of the program under review. Please comment on:

1. Management of the program. Comments:
2. Responsiveness of the program to emerging research and education opportunities. Comments:
3. Program planning and prioritization process (internal and external) that guided the development of the portfolio. Comments:
4. Additional comments on program management:

PART B. RESULTS OF NSF INVESTMENTS

NSF investments produce results that appear over time. The answers to the first three (People, Ideas and Tools) questions in this section are to be based on the COV's study of award results, which are direct and indirect accomplishments of projects supported by the program. These projects may be currently active or closed out during the previous three fiscal years. The COV review may also include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made. Incremental progress made on results reported in prior fiscal years may also be considered.

The following questions are developed using the NSF outcome goals in the NSF Strategic Plan. The COV should look carefully at and comment on (1) noteworthy achievements of the year based on NSF awards; (2) the ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcomes; and (3) expectations for future performance based on the current set of awards. NSF asks the COV to provide comments on the degree to which past investments in research and education have contributed to NSF's progress towards its annual strategic outcome goals and to its mission:
To promote the progress of science.
To advance national health, prosperity, and welfare.
To secure the national defense.
And for other purposes.

Excellence in managing NSF underpins all of the agency's activities. For the response to the Outcome Goal for Organizational Excellence, the COV should comment, where appropriate, on NSF providing an agile, innovative organization. Critical indicators in this area include (1) operation of a credible, efficient merit review system; (2) utilizing and sustaining broad access to new and emerging technologies for business application; (3) developing a diverse, capable, motivated staff that operates with efficiency and integrity; and (4) developing and using performance assessment tools and measures to provide an environment of continuous improvement in NSF's intellectual investments as well as its management effectiveness.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes (nuggets) as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 <u>OUTCOME GOAL for PEOPLE</u>: Developing "a diverse, competitive and globally engaged workforce of scientists, engineers, technologists and well-prepared citizens."

Comments:

B.2 <u>OUTCOME GOAL for IDEAS</u>: Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society." Comments:
B.3 <u>OUTCOME GOAL for TOOLS:</u> Providing "broadly accessible, state-of-the-art S&E facilities, tools and other infrastructure that enable discovery, learning and innovation." Comments:
B.4 <u>OUTCOME GOAL for ORGANIZATIONAL EXCELLENCE</u>: Providing "an agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices."[28] Comments:

[28] For examples and further detail on the Organizational Excellence Goal, please refer to pp. 19-21 of NSF's Strategic Plan, FY 2003-2008, at <http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf04201>.

PART C. OTHER TOPICS

C.1 Please comment on any program areas in need of improvement or gaps (if any) within program areas.

C.2 Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

C.3 Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

C.4 Please provide comments on any other issues the COV feels are relevant.

C.5 NSF would appreciate your comments on how to improve the COV review process, format and report template.

SIGNATURE BLOCK:

____

For the [Replace with Name of COV]
[Name of Chair of COV]
Chair

National Science Foundation
Directorate for Computer & Information Science & Engineering
4201 Wilson Boulevard, Room 1105
Arlington, VA 22230

TO: Deborah Crawford
Acting AD/CISE

FROM: Michael Foster
Division Director, Computing & Communication Foundations Division

DATE: February 23, 2007

SUBJECT: Report on Diversity, Independence, Balance, and Resolution of Conflicts for the CCF Committee of Visitors

This is my report to you on the diversity, independence, balance, and resolution of conflicts of the Committee of Visitors (COV) for the Division of Computing and Communication Foundations (CCF) held on June 15 and 16, 2006.

The COV, which was assembled to review the CCF Division, and whose report was presented to the CISE Advisory Committee on October 20, 2006, consisted of 20 members, of whom 15 are male and five are female. One of the members of the committee is African American, and one is Hispanic.

Seventeen of the COV members are from academia, one is from a National laboratory and two are from industry. The members' expertise reflects the research areas of CCF's clusters, i.e., foundations of computing processes and artifacts, emerging models and technologies for computation, and theoretical foundations. All invited COV members attended the meeting.

The Chair of the COV, Mary Jean Harrold, is an NSF ADVANCE Professor of Computing at the Georgia Institute of Technology. All the committee members from academia are full or associate professors, one of whom is a dean. The National Laboratory member is a Laboratory Fellow. One industry member is a technical manager while the other was vice president of research operations.

Six COV members are individuals who at the time of the meeting had not been applicants to CCF or its predecessor, the Computer-Communications Research Division, in the past five years and did not at the time of the meeting serve on any NSF Advisory Committee. Most COV members are familiar with CCF from having served on the CISE Advisory Committee or review panels, or are former or current grantees. None had proposals pending with CCF during the COV meeting. A conflict of interest briefing was held on the first day of the COV meeting. All COV members were required to complete the NSF Conflict of Interest form.

All academic members of the COV were barred from seeing proposals from their home institutions, and all noted conflicts were resolved by barring members from seeing specific proposals with which they had conflicts. No real or apparent conflicts arose during the course of the meeting.